Institut für Lebensmittel - und Ressourcenökonomik

Decision making under risk in agriculture

–

An experimental and survey based analysis

Dissertation

zur Erlangung des Grades

Doktorin der Agrarwissenschaften (Dr. agr.)

der Landwirtschaftlichen Fakultät

der Rheinischen Friedrich-Wilhelms-Universität Bonn

von

Manuela Meraner

aus

Bozen, Italien

Bonn 2017

Referent:	Professor Dr. Robert Finger
Korreferent:	Professor Dr. Thomas Heckelei
Tag der mündlichen Prüfung:	08.09.2017

Danksagung

An dieser Stelle möchte ich allen danken, die zum Gelingen dieser Arbeit beigetragen haben.

Besonderes möchte ich mich bei meinem Doktorvater Herrn Prof. Dr. Robert Finger bedanken, der nicht nur die wissenschaftliche Betreuung meiner Arbeit übernommen und deren Fortgang durch kritische und inspirierende Diskussionen bereichert, sondern mir durch einen hohen Grad an Freiheit, in der inhaltlichen Ausgestaltung und in meiner Arbeitsorganisation meine berufliche und persönliche Weiterentwicklung stets gefördert hat.

Für die bereitwillige Übernahme des Zweitgutachtens bedanke ich mich herzlich bei Herrn Prof. Dr. Thomas Heckelei. Durch die Anstellung am Lehrstuhl für Agrarpolitik als studentische Hilfskraft 2012 konnte ich mich für das Double Degree in Wageningen bewerben, womit der Grundstein für die nächsten fünf Jahre gelegt wurde, vielen Dank!

Meinen Kolleginnen und Kollegen der AECP Gruppe an der ETH Zürich und vor allem meinem Bürokollegen Niklas danke ich für die sowohl wissenschaftlichen als auch privaten – Diskussionen, ermutigende Worte und gute Ratschläge. Des Weiteren möchte ich mich bei meinen Freunden und Kolleginnen und Kollegen im ILR bedanken die mich während meines Aufenthaltes in Bonn aber auch darüber hinaus unterstützt haben.

Nicht zuletzt bedanke ich mich bei meiner Familie für die Verbundenheit mit der Landwirtschaft, die sie mir mitgegeben haben und die Möglichkeiten und Freiheiten meinen Interessen nachzugehen. Insbesondere bedanke ich mich bei Leo der während meines Dissertationsprojektes Teil meiner Familie und wichtigste moralische Stütze wurde.

„Okay, ladies, now let's get in formation, 'cause I slay"

Beyoncé Giselle Knowles-Carter

Abstract

Risk, and risk management are inherent to agricultural production. We distinguish two categories of factors influencing the farmers' decision on risk management strategy: external and internal factors. Factors external to the farm holding include the geographic, political and climatic environment. Internal factors include personal characteristics and the farmers' frame of reference. The presented studies in this thesis include analysis of external and internal determinants of the farmers' risk management decision in the German region North-Rhine-Westphalia focusing on (i) effects of contextualizing experimental risk preference elicitation methods, (ii) determinants of risk management choices amongst livestock farmers, (iii) underlying motives of agritourism farmers and (iv) characteristics of diversifying farmers in the peri-urban context.

Four unique case study analyses are conducted. First data collected from agricultural students is used to explore effects of contextualization in experimental risk preference elicitation methods. Second, data collected from livestock farmers is used for a holistic analysis of determinants of risk management choices. Third, agritourism and non-agritourism farmers are interviewed to explore underlying motives of farmers engaging in agritourism activities, and to find distinguishing farm, farmer and household characteristics of both groups. Fourth, data from farmers in the Ruhr-metropolitan area are collected to analyze their diversification decisions in the peri-urban context. The collected data is analyzed using econometric methods.

The results show that contextualization of experimental risk preference elicitation methods decreases misspecifications, and improves obtained data quality. Furthermore, the analysis of farmers' behavior under risk show that the individual farmer's frame of reference (i.e. risk preferences, perception and past experiences) determines the choice of risk management strategy. Additionally, results show that proximity to urban agglomerations incentivizes farmers to engage in on-farm, non-agricultural diversification. Farmers' decision to diversify is found to be opportunity driven, leading to the conclusion that improved information with regards to existing and new innovative diversification channels in the farming context is essential to improve rural development.

Keywords: risk management, experimental risk preference elicitation methods, risk perception, decision analysis, on-farm non-agricultural diversification

Zusammenfassung

Das Risikomanagement ist wesentlicher Bestandteil der landwirtschaftlichen Produktion. Es werden zwei Kategorien von Faktoren, die Risikomanagemententscheidungen von Landwirten beeinflussen, unterschieden: externe und interne Faktoren. Zu den externen Faktoren gehören geographische Merkmale des Betriebs sowie Klimafaktoren oder das politische Umfeld. Interne Faktoren sind persönliche Merkmale des Landwirts und der landwirtschaftlichen Familie sowie der Entscheidungsrahmen der Landwirte. In den vorliegenden Studien werden externe und interne Determinanten untersucht, welche die Entscheidungsfindung über die Risikomanagementstrategien der Landwirte im deutschen Bundesland Nordrhein-Westfalen beeinflussen, indem (i) Effekte der Kontextualisierung von experimentellen Methoden zur Risikopräferenzmessung, (ii) Determinanten von Risikomanagement-Entscheidungen bei Veredelungsbetrieben, (iii) zugrundeliegende Motive von Landwirten mit Agrartourismus sowie (iv) Charakteristika von diversifizierten Landwirten im peri-urbanen Raum untersucht werden.

In der vorliegenden Arbeit werden vier einzigartige Fallstudien analysiert. Erstens, werden Daten aus Experimenten mit landwirtschaftlichen Studenten verwendet, um Effekte der Kontextualisierung in experimentellen Methoden zur Risikopräferenzmessung zu erforschen. Zweitens werden Befragungsdaten von Veredelungsbetrieben gesammelt, um eine ganzheitliche Analyse der Determinanten der Risikomanagement-Entscheidungen durchzuführen. Drittens werden Landwirte von agrartouristischen und nicht-agrartouristischen Betrieben interviewt, um die zugrundeliegenden Motive des Einstiegs in den Agrartourismus und Unterschiede in den Charakteristika der Betriebe zu untersuchen. Viertens werden Daten von Landwirten im Ruhrgebiet analysiert um Erkenntnisse über Determinanten der Diversifikationsentscheidung im peri-urbanen Raum zu erhalten. Die gesammelten Daten werden mit Hilfe von ökonometrischen Methoden analysiert.

Die Ergebnisse zeigen, dass die Kontextualisierung von experimentellen Methoden der Risikopräferenzmessung Inkonsistenzen verringert und damit die Datenqualität verbessert wird. Darüber hinaus zeigt die Analyse des Risikomanagementverhaltens von Landwirten, dass der Entscheidungsrahmen des einzelnen Landwirts (d.h. Risikopräferenzen, Risikowahrnehmung und Erfahrungen mit Verlusten) die Wahl der Risikomanagementstrategie bestimmt. Die Ergebnisse zeigen außerdem, dass die Nähe zu einem urbanen Agglomerat die Landwirte dazu anregt, Diversifikationsaktivitäten zu betreiben. Die Entscheidung zur nicht-landwirtschaftlichen Diversifizierung ist gelegenheitsbedingt, daher ist eine bessere Information der Landwirte über bestehende und innovative Diversifikationsmöglichkeiten für die ländliche Entwicklung essentiell.

Schlagwörter: Risikomanagement, experimentelle Methoden zur Risikopräferenzmessung, Risikowahrnehmung, Entscheidungsanalyse, nicht-landwirtschaftliche Diversifikation

Contents

List of Tables

List of Figures

Abbreviations

AIC	Akaike's Information Criterion
BS	Business Statement
CAP	Common Agricultural Policy
CRRA	Constant Relative Risk Aversion
EU	European Union
EUT	Expected Utility Theory
EVA	Expected Values A
EVB	Expected Values B
iMPL	iterative Multiple Price List
LR	Likelihood Ratio
MPL	Multiple Price List
SA	Self-assessment
SEUT	Subjective Expected Utility Theory
SOEP	German Socio-Economic Panel
US	United States

Chapter 1

Introduction

Agriculture is an inherently risky business. Risks faced by farmers are numerous, and vary over space and time. Agricultural production is unique with regard to risk exposure, as it is mostly performed outside, or includes live material. This makes agriculture vulnerable to *production risks* such as extreme weather events, diseases and infestations not found in other sectors (Hardaker et al., 2004, Huirne, Meuwissen, and van Asseldonk, 2007, Anderson, Dillon, and Hardaker, 1977). Moreover, farmers are exposed to *market and price risks*, prices for inputs like fertilizer, fodder services and machinery, and outputs like milk, meat and cereal are not known a priori i.e. when production decisions are made leading to volatile commodity prices in agriculture. Additionally, price uncertainty is supported by open world markets, making developments more unpredictable for single farmers. By introducing income stabilization mechanisms like direct payments, guaranteed prices and buffer stocks governments seek to mitigate some market risks. Policy makers also seek to regulate numerous aspects of agriculture (e.g. the use of pesticides, animal welfare or land use restrictions) leading to far reaching consequences for agricultural production. Concurrently, high governmental support and regulations can lead to additional uncertainty for farmers when proposed price stabilization mechanisms are abolished or production regulations change. Thus, *institutional risks* refer to uncertainty associated with changes in policies. Furthermore, farmers face *financial risks* that are related to the financing of the farming business. Farms with a high debt-equity ratio are exposed to fluctuating interest rates on borrowed capital, or have difficulties in making new investments. Moreover, farmers face *human or personal* risks. They are common to all business operators, nevertheless, are especially threatening for family businesses in the agricultural sector. The death, illness or divorce of a family member or the main farm operator can lead to substantial consequences for the farm business. In summary, risks in agriculture are specific to geographical and climatic conditions, and depend on the current market, political, financial and private business environment. Moreover the farmers' exposure to risks is time sensitive. For example production risks can change due to increased catastrophic events such as floods and livestock epidemics caused by climate change. Furthermore, western policy makers are pressured to shift away from agricultural income support systems and publicly funded disaster programs, resulting in greater exposure of farmers to competitive markets and private risk management solutions (Meuwissen, van Asseldonk, and Huirne, 2008, Hardaker et al., 2004). Consequently, agricultural risk management is gradually shifted back to the farmers' decision making domain and hence gains importance for farmers, advisors, academics and policy makers. The farmers' choice of strategy to mitigate risks, i.e. the choice of risk management strategy is in focus of this thesis.

When farmers decide to mitigate the risk they are exposed to, they trade some of their expected returns for less variation in expected returns i.e. they shift parts of their resources (e.g. land, capital and labor) away from traditionally risky agricultural production towards a risk reducing strategy. Risk management strategies are categorized in measures to i) share risks with others (i.e. off-farm strategies) or ii) reduce risks within the farm (i.e. on-farm strategies) (Hardaker et al., 2004, Huirne, Meuwissen, and van Asseldonk, 2007). Building upon farm diversification literature (see e.g. van der Ploeg and Roep, 2003, Meraner et al., 2015), the latter is expanded by differentiating between on-farm agricultural and on-farm non-agricultural risk management strategies. The farms resource allocation under risk is illustrated in in Figure 1.1.

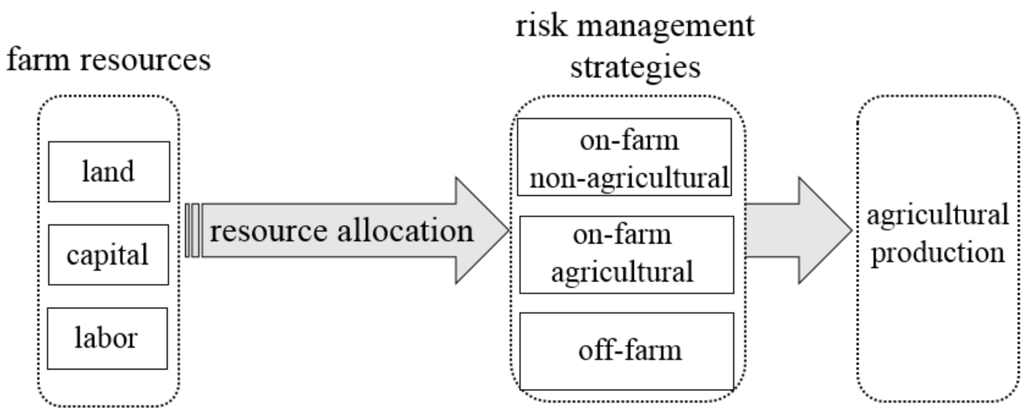


Figure 1.1: Farm resource allocation

Farmers choose to mitigate agricultural risk by shifting resources away from agricultural production towards three different dimensions. First, some risks can be mitigated on the farm by adapting agricultural production (e.g. choice of breed, investment in new technologies, combining different agricultural activities), and these shall be henceforth referred to as on-farm agricultural strategies. Second, farmers can keep resources on the farm but shift away from the agricultural production (e.g. non-agricultural diversification, holding reserves or cutting private expenses) these strategies are referred to as on-farm non-agricultural strategies. Third, risks are shared with others, i.e. resources are shifted away from agricultural production off the farm (i.e. off-farm strategies). This includes insurances, contracts with suppliers and buyers, trading on futures markets and off-farm investments or employment.

Following this brief introduction on agricultural risks and risk management strategies, theoretical foundations of decision making under risk, including risk preferences and risk perception are introduced. Additionally, the research questions addressed in the following chapters are presented. This first introductory chapter concludes with a summary of the main findings as well as pointers on potential areas for future research.

1.1 Theoretical foundations of decision analysis under risk

The various methods that have been developed for analyzing choices involving risk are collectively called decision analysis (Hardaker et al., 2004). The theoretical foundations of rational choice under uncertainty are commonly found in expected utility theory (EUT) developed by von Neumann and Morgenstern (1947) based on mathematical concepts established by Bernoulli (1738). In EUT, the rational decision maker chooses between risky alternatives by comparing expected utility values of different risky choices. Utility values refer to the weighted sums obtained by adding the utility values of outcomes multiplied by the respective probabilities (Chavas, 2004, Hardaker, 2006). EUT assumes that agents have perfect information on the probabilities and potential consequences related to risky events. The model has been criticized by numerous empirical studies as it fails to explain observable behavior (e.g.

Kahneman and Tversky, 1979, Savage, 1972, Allais, 1984). Savage (1972) expands EUT by adding a subjective component to the expected utility hypothesis (i.e. subjective expected utility (SEU)). SEU theory incorporates two components that have to be assessed when analyzing decision makers' choice under risk. This is, i) the decision makers subjective beliefs about the probability and impact of an uncertain outcome (i.e. subjective risk perception) as well as ii) the relative risk preferences for uncertain outcomes (i.e. risk preferences) of the decision maker, evaluated via the decision maker's utility function (Hardaker, 2006).

1.1.1 Risk perception

Risk perception is commonly defined as the combination of the probability of occurrence of an uncertain event and the consequential negative impact (Slovic, Fischhoff, and Lichtenstein, 1982). Moreover, risk perception is dependent on the objective risk the decision maker is facing, thus the perception of risk is domain-specific (i.e. depending on the risk source).

There are numerous ways to measure subjective risk perception. Most commonly, farmers' risk perception is measured using multi-item Likert scale-type questions or risk assessment scales of the two components of risk magnitude and likelihood of risks (see e.g. van Winsen et al., 2014, Assefa, Meuwissen, and Oude Lansink, 2016, Schaper, Bronsema, and Theuvsen, 2012). Furthermore, the visual impact method (Hardaker et al., 2004) or the exchangeability method (Baillon, 2008, Menapace, Colson, and Raffaelli, 2015a) have been used in the agricultural context. The choice of method is dependent on the cognitive abilities of the decision maker.

More sophisticated methods run the risk of a lower comprehension and could therefore lead to less meaningful results. Additionally, the choice of method is dependent on the objective risk farmers are facing (e.g. multiple unknown sources of risk vs. one dominating risk source).

1.1.2 Risk preferences

Regardless of their risk perception, different individuals have different attitudes towards risk. Risk attitudes are referred to as willingness to take risks or risk preferences. Choice under risk involves a trade-off between risk and expected return. Risk averse decision makers prefer relatively low levels of risk. In other words, they prefer to reduce the variations in possible outcomes and are in turn willing to sacrifice some expected return. Risk seeking decision makers prefer relatively high levels of risk and are willing to trade some expected return for a greater variation in possible outcomes (March and Shapira, 1987). In EUT, the attitude towards risk is defined by the shape of a utility function for money or wealth, with risk aversion depicted as diminishing marginal utility, i.e. increasing at a decreasing rate (Hardaker et al., 2004, Chavas, 2004).

Although the decision maker’s preferences for risk is assumed to be a partially stable feature of individual personality, there is evidence that risk preferences are influenced by variable factors such as mood, feelings, past experiences, ability to comprehend probability statements and the way in which problems are framed (Kahneman and Tversky, 1979, March and Shapira, 1987).

There are three major approaches to quantify risk attitudes: i) observed economic behavior, e.g. econometric analysis (Antle, 1987, Just and Pope, 2002), ii) non-incentivized questionnaires, e.g. Likert scales (Dohmen et al., 2011, Weber, Blais, and Betz, 2002), and iii) experimental methods, e.g. lotteries or direct elicitation of the utility function (Holt and Laury, 2002, Eckel and Grossman, 2002, Binswanger, 1981, Pennings and Garcia, 2001). The primary, and biggest advantage of experimental and survey based methods is the direct identification of otherwise latent variables, i.e. not directly observable variables (Cox and Harrison, 2008). Secondly, risk preferences can be elicited individually whereas field data used for econometric analysis is usually available on an aggregated level. Thirdly, experimental methods provide the possibility to control conditions for all participants, enabling researchers to analyze the decision makers' frame of decision making (Binswanger, 1981, Kahneman and Tversky, 1979). Nevertheless, the choice of risk preference elicitation method is dependent on the researchers resources (i.e. available data, time and budget) as well as on the decision makers' cognitive abilities (Charness, Gneezy, and Imas, 2013, Dave et al., 2010). Additionally, more complex methods like lotteries can be misunderstood by the participants provoking inconsistent behavior, leading to decreased data quality.

In the tradition of economic psychology, van Raaij (1981) is proposing a conceptual framework including personal characteristics as well as risk perception to explain economic behavior. Ilbery (1991) refers to "external" and "internal" drivers of farmers' decision making. More recently, van Winsen et al. (2014) propose a framework including i) farming attitudes, (ii) socio-demographic characteristics, (iii) past experiences, iv) risk attitude and (v) risk perception. By incorporating elements of the presented literature, the following classification of factors influencing farmer's decision making is proposed: i) environment, ii) personal characteristics and iii) frame of reference. The *environment* includes external farm characteristics (e.g. distance to urban centers or natural protection sites, soil quality, institutional environment etc.). Furthermore, *personal characteristics* are found to play a role in the choice of risk management strategy (e.g. age, education, gender). Within the agricultural context of decision analysis, characteristics specific to the agricultural business and household (e.g. farm size, succession of the farm business, availability of family workforce and the participation of the farm operator's spouse) are henceforth synonymously referred to as personal characteristics. Finally, the aforementioned subjective risk perception and risk preferences are part of the decision makers' *frame of reference*, and influence the decision makers' perceptual world, establishing the decision makers' reality on which decisions are based (Slovic, Fischhoff, and Lichtenstein, 1982, March and Shapira, 1987).

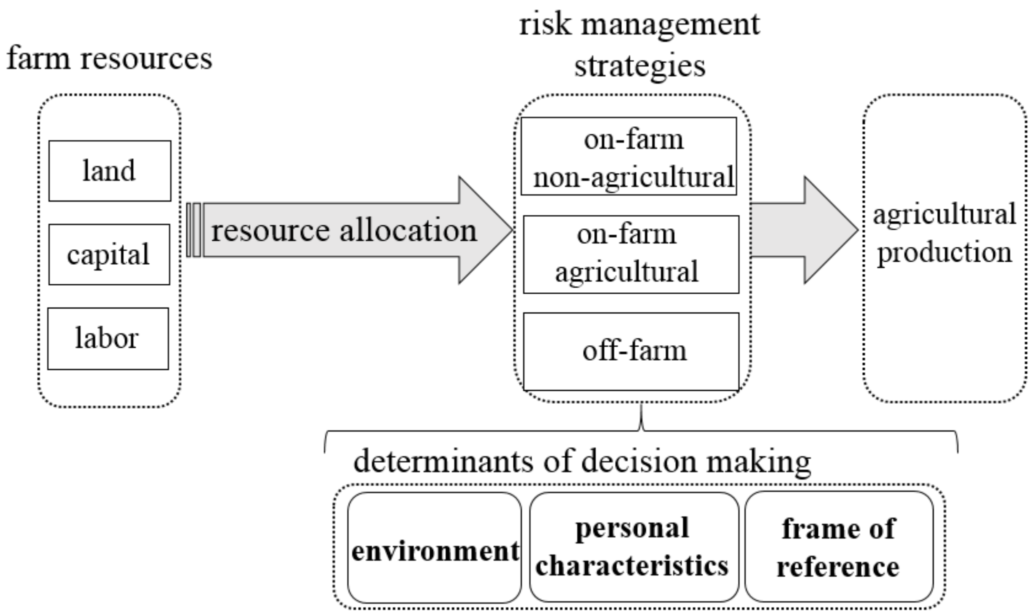


Figure 1.2: Factors affecting the farmers' decision on resource allocation

Based on the decision environment, personal characteristics and frame of reference, farmers choose the expected utility maximizing risk management portfolio from a large set of available strategies. Consequentially the farmers' choice of resource allocation depicted in Figure 1.1 can be expanded by the factors affecting the farmers' choice (see Figure 1.2).

1.2 Research objective and structure of the thesis

The overall objective of this thesis is to investigate farmers' choice of risk management strategies in North-Rhine-Westphalia. Therefore, first contextualized experimental and survey based risk preference elicitation methods are analyzed to identify an improved application to the agricultural context. Second, determinants of the farmers' choice of risk management portfolio is empirically analyzed. Third, motives behind the farmers' decision to diversify the farming activity towards agritourism are explored, and fourth the farmers' choice of on-farm non-agricultural diversification strategies is analyzed in the peri-urban context. The underlying research questions, and their contribution to the literature are presented in the following.

1.3.1 Research questions

To address the overarching objective of this thesis, four main research questions are specified.

(I) *Can contextualization of experimental risk preference elicitation methods reduce inconsistencies?*

The extent to which people are willing to take on risk constitutes their risk attitude. Understanding individual attitudes towards risk is closely linked to the goal of understanding and predicting economic behavior under uncertainty (like the farmers' choice of risk management strategy) and aiding policy-making. Researchers have developed a variety of different experimental and survey based methods to elicit individual risk preferences. Holt and Laury (2002) introduced the most prominent experimental method to elicit risk preference (Anderson and Mellor, 2009, Hellerstein, Higgins, and Horowitz, 2013). The presented lottery is based on a multiple price list (MPL) format, where subjects successively pick the option they prefer in a list of ten choices. Survey based methods traditionally include multi-item, Likert-type scales. The simplest version is asking participants to self-assess their general willingness to take risks on a scale from 0 to 10 (Dohmen et al., 2011).

The biggest disadvantage attached to experimental methods are inconsistencies in the sample populations' behavior. Here, two types of inconsistencies are distinguished: The first type of within-method inconsistencies refer to a violation of expected utility assumptions within a MPL setting. Second, between-method inconsistencies describe non-consistent risk preferences of an individual when different elicitation methods are used. Inconsistencies lead to a decrease of data quality, generating biased real-world conclusions on human behavior and policy recommendations. A large body of research aiming to overcome these issues discusses new methods to elicit risk preferences (Crosetto and Filippin, 2013, Dave et al., 2010, Lejuez et al., 2003) leading to a vast growth of experimental methods to elicit risk preferences over the last decades without a solution to the problem of inconsistent behavior. However, only little research has been done on the impact of contextual adjustments of the classical abstract, context free lottery setting. Here, contextualized lotteries refer to ones where subject specific real world framing of the lottery task is employed. Abstract lotteries, on the other hand, refer to ones where the instructions are kept abstract and context free (Alekseev, Charness, and Gneezy, 2017). Contextualization is particularly promising for field experiments dealing with participants not used to abstract contexts like farmers. Therefore, chapter 2 of this thesis contributes to the literature by comparing within-method inconsistencies in a controlled experiment among agricultural students using a subject specific contextual framing of the classical Holt and Laury (2002) lottery versus the original abstract and context free frame. Additionally, the effect of contextualization of the MPL on between-method inconsistency is analyzed by comparing risk preferences elicited using a MPL and a general self-assessment task (following Dohmen et al., 2011).

(II) What determines the choice of agricultural risk management strategies?

In agricultural production, farmers are confronted with a wide and increasing range of production, market, financial and institutional risks. Consequently, the portfolio of risk management strategies available to farmers is large and growing, but little is known about the determinants leading to the farmer's choice of an optimal risk management portfolio. The farmer's choice of risk management strategies is determined by farm, farmer and household characteristics. Within the set of farmer characteristics, individual risk perception, risk preferences and experienced past losses need to be considered (see Figure 1.2) (Slovic, Fischhoff, and Lichtenstein, 1982, Hardaker et al., 2004).

Literature on farmers' choice of risk management strategies is often focusing on the adoption of single activities such as, insurances (Menapace, Colson, and Raffaelli, 2015b, Finger and Lehmann, 2012). However, farmers use a large portfolio of different risk management strategies in order to react to different risk sources (Musser and Patrick, 2002, Meuwissen, Huirne, and Hardaker, 2001). Thus, the study presented in chapter 3 aims to contribute to the existing literature by analyzing the effect of farm, farmer and household characteristics on the farmer's choice of a large set of risk management strategies.

(III) What are underlying motives of the farmer's choice to diversify into agritourism?

Farm diversification is of key relevance to the agricultural sector as it contributes to rural development, and reduces agricultural income risks by spreading the farm households' sources of income. About one third of farmers in the EU diversify into non-agricultural activities (European Parliamentary Research Service, 2016), using their own assets (land, buildings, labor) outside the core agricultural production to stabilize and/or increase their income. The underlying theoretical framework of farmers' resource allocation is introduced in Figure 1.1. Additionally, farm diversification in general, and agritourism in particular contributes to rural development and improves economic opportunities and accessibility in disadvantaged rural regions (European Commission, 1990).

There is a large body of research focusing on observable farm, farmer and household characteristics determining the farmers' diversification decision (e.g. Meraner et al., 2015, Ilbery et al., 1998, McNamara and Weiss, 2005). Additionally, underlying push and pull motives of the farmers' decision to start an agritourism venture beyond observable characteristics are analyzed (e.g. Barbieri, 2009, Hansson et al., 2013). Moreover, research is focusing on the income stabilizing characteristics of agritourism, interpreting agritourism as a farm risk management strategy (e.g. Kostov and Lingard, 2003, Meuwissen et al., 2001). Furthermore, there is research focusing on the importance of the farm operator's spouse and underlying motives when analyzing drivers of agritourism (e.g. Haugen and Vik, 2008, Ollenburg and Buckley, 2007, McGehee, Kim, and Jennings, 2007, Hansson et al., 2013). The study presented in chapter 4 helps to better understand the importance of push and pull motives, as well as the farm households family structure in the decision making process. This provides valuable information for policy makers and advisors, aiming to support rural development by supporting agritourism activities.

(IV) What determines on-farm non-agricultural diversification in the peri-urban Ruhr metropolitan area?

In peri-urban areas the farmer's decision environment is characterized by increased demand, short supply chains and direct marketing opportunities leading to an increased uptake of farm diversification activities (Wilson, 2007, Zasada et al., 2011, Heimlich and Barnard, 1992). However, farms in peri-urban areas also face high opportunity costs for land and labor, as well as increased public control (Monaco et al., 2017). Thus, analyzing farm diversification in the peri-urban context is of particular interest. The case study region 'Ruhr Metropolis' is especially interesting as it is the largest polycentric agglomeration in Germany, and has the highest average population density in North-Rhine-Westphalia.

Previous research on on-farm non-agricultural diversification has shown that due to synergies between activities (e.g. between farm processing and sales activities), farm diversification strategies are often combined (Meraner et al., 2015, Haugen and Vik, 2008, Carter, 1998). Chapter 5 presents an analysis of the farm environment, the farmers' frame of reference (including risk perception, risk preferences and past experiences), as well as personal characteristics of the farm, farmer and farm household as illustrated in Figure 1.2. A two-step analysis is used to shed light on determinants of the farmers' decision to engage in on-farm non-agricultural diversification and diversification intensity.

1.3.2 Structure of the thesis

Chapters 2-5 constitute the main body of the thesis, addressing the research questions and the objective of this thesis in independent analyses. Chapter 2 answers research question (I) by analyzing results of a controlled experiment conducted online comparing consistencies of responses in framed and standard lotteries. This chapter is based on the paper currently under review titled "Using involvement to reduce inconsistencies in risk preference elicitation". The article in chapter 3 addresses research question (II) by presenting a holistic analysis of the farmers' choice of risk management portfolio, determined by farmers' risk preferences, perception and past experiences among other farm, farmer and household characteristics. The corresponding article is titled "Risk perceptions, preferences and management strategies: Evidence from a case study using German livestock farmers". The analysis presented in chapter 4 answer research question (III) by including the main farm operator and the spouses' role in the farm management decision as well as expanding determinants of decision making by underlying motives. Focus lies on the farmers' decision to start an agritourism venture. The chapter contains the article: "Determinants and motives for agritourism activities: A German case study". Finally, research question (IV) is addressed in chapter 5, which includes a two-step analysis of the farmers' diversification decision and choice of diversification intensity in the peri-urban context. It is based on the article titled: "Diversification intensity in peri-urban areas: the Ruhr metropolitan region".

1.3 Summary of main findings and conclusion

For each of the articles presented in chapter 2-5, main findings are summarized in this section. This is followed by conclusions, placing results into the broader context of the overall research question and limitations of the analysis.

1.4.1. Summary of main findings

(I) Contextualization experimental risk preference elicitation methods reduces inconsistent behavior

The analysis of data collected in an online experiment with 244 German agricultural students to answer research question (I) reveals a reduction of inconsistencies in the students' responses when using a contextualized framing of the classical lottery introduced by Holt and Laury (2002) (in the further referred to as Holt and Laury lottery). Contextualization of the Holt and Laury lottery reduces behavior violating assumptions of expected utility theory repeatedly found for abstract Holt and Laury lottery frames. Furthermore, a comparison of risk preferences elicited with the contextualized lottery and a Likert scale general self-assessment task (following Dohmen et al., 2011) shows a reduction of between-method inconsistencies. The agricultural context frame increases the students, motivation and time spent on the task. Increased motivation is in turn leading to less within- and between-method inconsistent behavior. Adding a meaningful context specific to the addressed target group (e.g. agricultural investment in the case of agricultural students) enhances understanding of the task. This is of particular importance when tasks require sophisticated reasoning. Hence, there is evidence that contextualization of risk preference elicitation tasks can lead to better data quality and better explanatory power of the elicited risk preferences.

(II) The choice of agricultural risk management strategies is depending on farm farmer's and household characteristics.

We use a holistic approach to analyze the farmers' choice of risk management strategies to answer research question (II), by including a broad list of risk management strategies as well as personal characteristics of the farm farmer and farm household. Based on the theoretical framework of subjective utility theory, the farmer's personal characteristics include elements of the farmer's frame of reference i.e. subjective risk perception of different risk sources, risk preferences (comparing three different elicited methods) and experiences with major losses in the past. The analysis is based on data collected via a self-administered paper pencil survey among 64 livestock farmers in North-Rhine-Westphalia. The survey includes a large set of risk management strategies that are in the latter analysis grouped depending on the farm dimension where resources are shifted towards (i.e. off-farm, on-farm agricultural, on-farm non-agricultural).

Furthermore, risk perception is measured using the average over two Likert-type scales, quantifying the perceived likelihood and impact of uncertainty. Farmers' risk preferences are elicited using three different methods in order to additionally interpret differences in the predictive power of real life behavior for different methods. The influence of farm, farmer and household characteristics on the choice of risk management strategy is analyzed using a multinomial probit model.

Generally, risk averse farmers are found to be more likely to choose on-farm risk management strategies over off-farm strategies. More specifically, risk aversion in the financial domain is linked to a larger probability of farmers choosing primarily on-farm agricultural strategies. Risk aversion in general and, in other domains is linked to a larger probability of farmers choosing primarily on-farm non-agricultural strategies. This points to a strong need for domain specific risk preference elicitation. Furthermore, results show that risk perception, age, subjective numeracy, farm succession, farm size and the proportion of rented land have a significant impact on farmers' risk behavior.

(III) Farmers starting agritourism ventures are mainly driven by opportunities arising from the vicinity to a city

The analysis of farmers' motives to start agritourism to answer research question (III) is based on data collected via semi-structured face-to-face interviews with 33 farmers in the surroundings of the city of Muenster in North-Rhine-Westphalia. In total 24 motives underlying the farmers' decision to start agritourism are ranked by the interviewed farmers on a five point Likert scale (ranging from 1 = “not important” to 5 = “very important”). The strongest motive for all interviewed farmers is the desire to exploit new market opportunities, followed by the joy to work in agritourism and a passion for working with people. Least important motives are tax reasons and the wish to create employment opportunities for the future generation. Pull motives are on average more relevant for the farmers’ agritourism decision. This means that farmers deciding to start agritourism on the farm are more opportunity, and less necessity driven. Furthermore, the analysis highlights the importance of joined work of the farming couple in the agritourism activity. Farmwomen are found to be more often responsible for the realization of activities than the initialization and planning. An additional comparison of characteristics on the farm, farmer and household level of agritourism farms and non-agritourism farms in the same area reveals that agritourism farms are smaller, more diversified and more often run by female farm operators. Agritourism farm operators are also more risk averse, indicating that more risk averse producers allocate more resources to activities with less income volatility like agritourism.

(IV) On-farm non-agricultural diversification is an important risk management strategy in the peri-urban Ruhr metropolitan area

In order to answer research question (IV) data from an online survey targeting farmers in the peri-urban Ruhr metropolitan area is analyzed. The data is enriched with geographical information on 156 participating farmers. A double hurdle model is used to first analyze the farmers' decision to shift resources away from agricultural production towards on-farm non-agricultural diversification and in a second step to analyze the intensity of diversification.

In the densely populated case study area, farms are to a large share diversified, exploiting the advantages of the proximity to the urban agglomeration. The farmers' frame of reference plays an important role in determining the diversification decision. Farmers that perceive market and price risks to be high, and farmers that experienced severe losses due to institutional risks are less likely to choose an on-farm non-agricultural diversification strategy. However, risk aversion, high perception of labor risk and experienced losses due to market risks decrease the farmers' likelihood to diversify. Personal characteristics like the farmer's age, occupation and succession also influence the diversification decision. More specifically, younger, full-time farming farmer with a secured succession are more likely to seek income stabilizing on-farm non-agricultural diversification. Diversification intensity is positively associated with farms that are producing high value crops. These farm types are more likely to exploit advantages of short supply chains, direct marketing opportunities and the increased environmental awareness of consumers regarding agricultural production in peri-urban areas.

1.4.2. Conclusion and limitations

With regard to the overall research objective of this thesis which can be described as an investigation of the farmers' choice of risk management strategies in North-Rhine-

Westphalia, the results can be split in two parts: the first one focusing on improvements of experimental risk preference elicitation, and the second one on empirical evidence for determinants of farmers risk management choices.

The analysis of contextualization effects on inconsistencies in experimental risk preference elicitation elaborated on in research question (I), shows that context-rich language adapted to the participants real world experiences in a controlled experiment reduces inconsistencies. Thus, the commonly used argument for using an abstract context in experimental economics to achieve experimental control is challenged by the attained increase in participants' understanding and motivation in a contextualized experiment. Overall, the reduction of inconsistencies in the contextualized experiment improves data quality. However, it is important to acknowledge that contextualization of instructions may affect participants' behavior in the experiment which acts as a disadvantage. Nonetheless, this effect can be appropriate as it relates to the research question and better explains real world behavior in a subject-relevant context i.e. increasing external validity.

Besides the importance of risk preferences as determinant of the risk management choices of livestock farmers in North-Rhine-Westphalia (research question II), other elements of the farmers' frame of reference, like risk perception, risk literacy and experiences with severe losses are found to be significant. Farmers perceiving market and price risks to be severe are more likely to choose risk sharing strategies. Hence, a strong perception of volatile prices and insecure markets leads farmers to choose more strategies targeting those risks. High risk aversion, low risk literacy and experiences with severe losses in the past have a positive effect on the uptake probability of on-farm risk management strategies as opposed to off-farm strategies. In other words, farmers that seek to avoid risks, experienced severe losses in the past and are less able to acquire and decode information on risk (i.e. compare and transform probabilities and proportions) are less likely to share risks with third parties. These farmers could profit most from additional support by advisors and policy makers which need to tailor risk communication to the individual numeracy skills of farmers. Additionally, the strong influence of the farmers' frame of reference points to the need for more in-depth insights into underlying motives and the role of other farm family members in risk management choices. The analysis of farmers' determinants to start agritourism activities focuses on the farmers' underlying motives (research question III). Findings highlight that farmers choosing agritourism as a risk management strategy in Muenster are opportunity driven. Interviewed farmers state that making use of market opportunities emerging from the farms favorable location (e.g. proximity to the city and recreational areas) enabled them to start the agritourism venture. Furthermore, the generation of extra income, family structure (i.e. the participation of farmwomen), and intrinsic motivation to work with people on the farm are important factors. Findings indicate that the farms proximity to a city has a positive effect on the uptake of agritourism. Yet, the comparison of agritourism and non-agritourism farms in the same area shows that larger farms, with more risk seeking, male main farm operators choose other risk management strategies over agritourism. These results point towards the need to further investigate the role of the farms geographical environment and market opportunities in peri-urban areas. Thus, when analyzing the farmers' choice of on-farm non-agricultural diversification strategies in the peri-urban Ruhr metropolitan area characteristics of the farms geographical environment are included (research question IV). On-farm non-agricultural diversification is a viable farm risk management strategy in the peri-urban context. Nevertheless, not all farms have the same conditions enabling them to diversify their activities. Farms that produce high value crops, with a younger farmer and secured succession of the business are more likely to take advantage of short supply chains and increasing local customer demand, characteristic to peri-urban areas. Farm diversification is strongly determined by the farmers' frame of reference. Results show that past losses due to changes in the political agenda and market volatility influence the farmers' decision to engage in on-farm non-agricultural diversification. This leads to the conclusion that the current developments of the CAP towards supporting farmers to monetize multifunctional characteristics of agriculture is fruitful. Furthermore, risk aversion has a negative effect on the uptake probability of on-farm non-agricultural diversification activities. We conclude that risk averse farmers prefer to shift the farming risk towards third parties. Moreover, due to the already high degree of on-farm non-agricultural diversification in the area for some activities saturation effects can play an important role making the entrepreneurial decision to start an on-farm non-agricultural activity more risky.

The empirical case studies included in this thesis show that farming systems are very heterogeneous, offering different risk management opportunities to farmers, while also shaping the individual frame of reference within which farmers are forming their decisions. Policies should therefore be tailored to account for the special role of these farming systems, with respect to, but also beyond diversification decisions. Along these lines, when designing new policies like the income stabilization tool in Europe, agricultural policy makers and advisers also need to recognize that risk and risk aversion influence farmers' management decisions. Further research needs to account for the large risk management portfolio available to farmers, while also including risk preferences, perceptions, and past experiences in the decision making analysis. The widespread analysis of factors influencing one single strategy ignores the context of overall risk the farm is exposed to. Along these lines, future research needs to account for the family business structure dominant in the agricultural sector. Decisions in the agricultural risk management context are not made by the main farm operator in isolation but are influenced by decisions of other family members, e.g. spouse or potential successor. Consequently, their decision making frame of reference plays a role in explaining farm risk management choices. Moreover, the analysis of risk management strategies should consider a longer time horizon, enabling researchers to dig deeper into the underlying determinants of farm risk management choices.

1.4 References

Alekseev, Aleksandr, Gary Charness, and Uri Gneezy. 2017. "Experimental methods: When and why contextual instructions are important." *Journal of Economic Behavior & Organization* 134:48-59.

Allais, Maurice. 1984. "The Foundations of the Theory of Utility and Risk Some Central Points of The Discussions at the Oslo Conference." In *Progress in Utility and Risk Theory*, edited by Ole Hagen and Fred Wenstop, 3-131. Dordrecht NL, Boston USA, Lancaster UK: D. Reidel Publishing Company.

Anderson, Jock R., John L. Dillon, and Brian J. Hardaker. 1977. *Agricultural decision analysis*. Iowa City USA: Iowa State University Press.

Anderson, Lisa R., and Jennifer M. Mellor. 2009. "Are risk preferences stable? Comparing an experimental measure with a validated survey-based measure." *Journal of Risk and Uncertainty* 39 (2):137-160.

Antle, John M. 1987. "Econometric estimation of producers' risk attitudes." *American Journal of Agricultural Economics* 69 (3):509-522.

Assefa, Tsion T., Miranda P. M. Meuwissen, and Alfons G. J. M. Oude Lansink. 2016. "Price risk perceptions and management strategies in selected European food supply chains: An exploratory approach." *NJAS - Wageningen Journal of Life Sciences*.

Baillon, Aurélien. 2008. "Eliciting subjective probabilities through exchangeable events: An advantage and a limitation." *Decision Analysis* 5 (2):76-87.

Barbieri, Carla. 2009. "A comparison of agritourism and other farm entrepreneurs: Implications for future tourism and sociological research on agritourism." Northeastern Recreation Research Symposium, Bolton Landing, NY, USA, March 2008.

Bernoulli, Daniel. 1738. *Specimen theoriae novae de mensura sortis*. Vol. 5, *Commentarii Academiae Scientiarum Imperialis Petropolitae*: Gregg.

Binswanger, Hans P. 1981. "Attitudes toward risk: Theoretical implications of an experiment in rural India." *The Economic Journal* 91 (364):867-890.

Carter, Sara. 1998. "Portfolio entrepreneurship in the farm sector: indigenous growth in rural areas?" *Entrepreneurship & Regional Development* 10 (1):17-32.

Charness, Gary, Uri Gneezy, and Alex Imas. 2013. "Experimental methods: Eliciting risk preferences." *Journal of Economic Behavior & Organization* 87:43–51.

Chavas, Jean-Paul. 2004. *Risk analysis in theory and practice*. San Diego USA, London UK: Elsevier Academic Press.

Cox, James C., and Glenn W. Harrison. 2008. "Risk aversion in experiments: An introduction." In *Risk aversion in experiments*, edited by James C. Cox and Glenn W. Harrison, 1-7. online: 08 Mar 2015: Emerald Group Publishing Limited.

Crosetto, Paolo, and Antonio Filippin. 2013. "The “bomb” risk elicitation task." *Journal of Risk and Uncertainty* 47 (1):31-65.

Dave, Chetan, Catherine C. Eckel, Cathleen A. Johnson, and Christian Rojas. 2010. "Eliciting risk preferences: When is simple better?" *Journal of Risk and Uncertainty* 41 (3):219-243.

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, and Gert G. Wagner. 2011. "Individual risk attitudes: Measurement, determinants, and behavioral consequences." *Journal of the European Economic Association* 9 (3):522–550.

Eckel, Catherine C., and Philip J. Grossman. 2002. "Sex differences and statistical stereotyping in attitudes toward financial risk." *Evolution and Human Behavior* 23 (4):281–295.

European Commission. 1990. *Community Action to Promote Rural Tourism - Communication from the Commission*.

European Parliamentary Research Service. 2016. *Farm diversification in the EU*. European Parliament: Briefing.

Finger, Robert, and Niklaus Lehmann. 2012. "The influence of direct payments on farmers’ hail insurance decisions." *Agricultural Economics* 43 (3):343-354.

Hansson, Helena, Richard Ferguson, Christer Olofsson, and Leena Rantamäki-Lahtinen. 2013. "Farmers' motives for diversifying their farm business – The influence of family." *Journal of Rural Studies* 32:240-250.

Hardaker, Brian J. 2006. "Farm risk management: past, present and prospects." *Journal of Farm Management* 12 (10):593-612.

Hardaker, Brian J., Ruud B. M. Huirne, Jock R. Anderson, and Gudbrand Lien. 2004. *Coping with risk in agriculture*. 2 ed. Wallingford UK, Cambridge USA: CABI publishing.

Haugen, Marit S., and Jostein Vik. 2008. "Farmers as entrepreneurs: the case of farm-based tourism." *International Journal of Entrepreneurship and Small Business* 6 (3):321-336.

Heimlich, Ralph E., and Charles H. Barnard. 1992. "Agricultural adaptation to urbanization: Farm types in northeast metropolitan areas." *Northeastern Journal of Agricultural and Resource Economics* 21 (1):50-60.

Hellerstein, Daniel, Nathaniel Higgins, and John Horowitz. 2013. "The predictive power of risk preference measures for farming decisions." *European Review of Agricultural Economics* 40 (5):807–833.

Holt, Charles A., and Susan K. Laury. 2002. "Risk aversion and incentive effects." *American Economic Review* 92 (5):1644–1655.

Huirne, Ruud B. M., Miranda P. M. Meuwissen, and Marcel A. P. M. van Asseldonk. 2007. "Importance of whole-farm risk management in agriculture." In *Handbook of operations research in natural resources*, edited by Andres Weintraub, Carlos Romero, Trond Bjørndal and Rafael Epstein, 3-15. New York USA: Springer US.

Ilbery, Brian W. 1991. "Farm diversification as an adjustment strategy on the urban fringe of the West Midlands." *Journal of Rural Studies* 7 (3):207–218.

Ilbery, Brian W., Ian Bowler, Gordon Clark, Alastair Crockett, and Alastair Shaw. 1998. "Farmbased tourism as an alternative farm enterprise: A case study from the northern Pennines, England." *Regional Studies* 32 (4):355–365.

Just, Richard E., and Rulon D. Pope, eds. 2002. *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*. 1 ed, *Natural Resource Management and Policy*. New York USA: Springer.

Kahneman, Daniel, and Amos Tversky. 1979. "Prospect theory: An analysis of decision under risk." *Econometrica: Journal of the Econometric Society*:263-291.

Kostov, Philip, and John Lingard. 2003. "Risk management: a general framework for rural development." *Journal of Rural Studies* 19 (4):463-476.

Lejuez, Carl W., Will M. Aklin, Michael J. Zvolensky, and Christina M. Pedulla. 2003. "Evaluation of the Balloon Analogue Risk Task (BART) as a predictor of adolescent real-world risk-taking behaviours." *Journal of Adolescence* 26 (4):475-479.

March, James G., and Zur Shapira. 1987. "Managerial perspectives on risk and risk taking." *Management Science* 33 (11):1404-1418.

McGehee, Nancy G., Kyungmi Kim, and Gayle R. Jennings. 2007. "Gender and motivation for agri-tourism entrepreneurship." *Tourism Management* 28 (1):280–289.

McNamara, Kevin T., and Christoph Weiss. 2005. "Farm Household Income and On- and Off-Farm Diversification." *Journal of Agricultural and Applied Economics* 37 (1):37-48.

Menapace, Luisa, Gregory Colson, and Roberta Raffaelli. 2015a. "Climate change beliefs and perceptions of agricultural risks: An application of the exchangeability method." *Global Environmental Change* 35:70-81.

Menapace, Luisa, Gregory Colson, and Roberta Raffaelli. 2015b. "A comparison of hypothetical risk attitude elicitation instruments for explaining farmer crop insurance purchases." *European Review of Agricultural Economics* 43 (1):113-135.

Meraner, Manuela, Wim Heijman, Tom Kuhlman, and Robert Finger. 2015. "Determinants of farm diversification in the Netherlands." *Land Use Policy* 42:767-780.

Meuwissen, Miranda P. M., Brian J. Hardaker, Rudd B. M. Huirne, and Aalt A. Dijkhuizen. 2001. "Sharing risks in agriculture; principles and empirical results." *NJAS - Wageningen Journal of Life Sciences* 49 (4):343–356.

Meuwissen, Miranda P. M., Rudd B. M. Huirne, and Brian J. Hardaker. 2001. "Risk and risk management: an empirical analysis of Dutch livestock farmers." *Livestock Production Science* 69 (1):43–53.

Meuwissen, Miranda P. M., Marcel A. P. M van Asseldonk, and Ruud B. M. Huirne. 2008. *Income Stabilisation in European Agriculture: Design and Economic Impact of Risk Management Tools*. Wageningen NL: Wageningen Academic Publishers.

Monaco, Federica, Ingo Zasada, Dirk Wascher, Matjaž Glavan, Marina Pintar, Ulrich Schmutz, Chiara Mazzocchi, Stefano Corsi, and Guido Sali. 2017. "Food Production and Consumption: City Regions between Localism, Agricultural Land Displacement, and Economic Competitiveness." *Sustainability* 9 (1):96.

Musser, Wesley N., and George F. Patrick. 2002. "How Much does Risk Really Matter to Farmers?" In *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*, edited by Richard E. Just and Rulon D. Pope, 537-556. Boston USA: Springer US.

Ollenburg, Claudia, and Ralf Buckley. 2007. "Stated economic and social motivations of farm tourism operators." *Journal of Travel Research* 45 (4):444-452.

Pennings, Joost M. E., and Philip Garcia. 2001. "Measuring producers' risk preferences: A global risk-attitude construct." *American Journal of Agricultural Economics* 83 (4):993-1009.

Savage, Leonard J. 1972. *The Foundations of Statistics*. New York USA: Courier Corporation.

Schaper, Christian, Hauke Bronsema, and Ludwig Theuvsen. 2012. *Risikomanagement in der Landwirtschaft*. Schriftenreihe des Landesamtes für Umwelt, Landwirtschaft und Geologie 36, 36.

Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein. 1982. "Why Study Risk Perception?" *Risk Analysis* 2 (2):83–93.

van der Ploeg, Jan Douwe, and Dirk Roep. 2003. "Multifunctionality and rural development: the actual situation in Europe." In *Multifunctional agriculture: a new paradigm for European agriculture and rural development*, edited by Guido van Huylenbroeck and Guy Durand, 37-53. Hampshire UK: Ashgate.

van Raaij, Fred W. 1981. "Economic psychology." *Journal of Economic Psychology* 1 (1):1–24.

van Winsen, Frankwin, Yann de Mey, Ludwig Lauwers, Steven van Passel, Mark Vancauteren, and Erwin Wauters. 2014. "Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer’s adoption of risk management strategies." *Journal of Risk Research* 19 (1):56-78.

von Neumann, John, and Oskar Morgenstern. 1947. *Theory of games and economic behavior*. 2 ed. Princeton USA, Woodstock UK: Princeton University Press.

Weber, Elke U., Ann-Renee Blais, and Nancy E. Betz. 2002. "A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors." *Journal of Behavioral Decision Making* 15 (4):263–290.

Wilson, Geoffrey Alan. 2007. *Multifunctional agriculture: a transition theory perspective*. Wallingford UK, Cambridge USA: CABI publishing.

Zasada, Ingo, Christian Fertner, Annette Piorr, and Thomas Sick Nielsen. 2011. "Peri-urbanisation and multifunctional adaptation of agriculture around Copenhagen." *Geografisk Tidsskrift-Danish Journal of Geography* 111 (1):59–72.

Chapter 2

Using involvement to reduce inconsistencies in risk preference elicitation*

* Meraner, M., O. Musshoff and R. Finger (under review)

Abstract

Empirical research aiming to elicit risk attitudes faces problems of within- and between-method inconsistencies, which reduce the explanatory and predictive power of risk research. In this paper, we examine the particular relevance of context and task involvement on the elicitation of risk preferences and inconsistencies. We find in a sample of 244 German agricultural students, that a real life and subjects' context specific framing of a multiple price list triggers the participants' motivation. Higher motivation is in turn triggering analytic/systematic thinking and is leading to fewer within- and between-method inconsistencies. We show that within-method consistency is increased with subjects' increasing task and context involvement. However, between-method consistency is significantly increased by the subjects' task involvement; context involvement, has a less distinct effect on between-method consistency. We show that by framing a risk elicitation method according to the subjects' specific context, involvement can be triggered and inconsistencies and misspecifications can be reduced.

Keywords: between- and within-method inconsistencies, risk preference elicitation, involvement

JEL Classifications: C91 D81

2.1 Introduction

The extent to which people are willing to take on risk constitutes their risk attitudes, which in turn plays a major role in explaining their behavior. Consequentially risk attitudes are of high importance for decisions in many economics-related contexts. Understanding individual attitudes towards risk is closely linked to the goal of understanding and predicting economic behavior and giving policy advice.

There is a growing literature on how to measure risk attitudes and accordingly a large body of literature focuses on the selection of the right elicitation method (for an extensive overview see Charness, Gneezy, and Imas, 2013). Many of these methods are based on the same theoretical foundation of expected utility theory (EUT) and thus claim to measure the subjects' "true" risk preference. Consequently, risk preferences elicited using different methods should be comparable and accurate. However, because of inconsistencies (i.e. errors) in the individuals' responses these criteria are often not met in empirical work by the participants (Csermely and Rabas, 2017). More specifically, three ways of consistency are distinguished in the literature i) between-method consistency of several elicitation methods (Crosetto and Filippin, 2015, Dohmen et al., 2011, Eckel and Grossman, 2002), ii) within-method consistency of the same elicitation method at one point in time (Holt and Laury, 2002, Jacobson and Petrie, 2009), and iii) within-method consistency of the same elicitation method over two points in time (Andersen et al., 2008, Harrison and Rutström, 2008). Inconsistencies lead to biases in the interpretation of the decision makers' risk preferences and consequently biased real-world conclusions on human behavior and policy recommendations. In order to overcome these inconsistency problems, past research has frequently reached out to new methods to elicit risk preferences (Charness, Gneezy, and Imas, 2013). This did not necessarily result in lower inconsistencies but contributed to increasing problems of comparability of the different studies. Furthermore, a large body of literature seeks to identify the correct assumptions about the nature of the data gathered and thus ‘errors’ made by the subjects in the experiments generating the data under analysis (Carbone and Hey, 2000, Wilcox, 2008).

Based on the seminal work of Kahneman and Tversky (1979), numerous studies have shown that decision making is strongly influenced by the decision frame (i.e. decision makers respond differently to different but objectively equivalent descriptions of the same problem). Furthermore, Kahneman (2003) defined two different ways of processing information applied in different contexts of decision making depending on the motivation and capability of the decision maker. The motivation of subjects is expected to be dependent on the subject-specific relevance of the task, or, in other words, the subjects’ involvement with it. The subject-specific relevance is expected to be influenced by the decision frame, so that framing can trigger task involvement.

And indeed, there is evidence in different experimental settings that the application of context is enhancing understanding of experimental tasks, reduces mistakes and increases quality of results (see Alekseev, Charness, and Gneezy, 2017 for an extensive overview). However, there is evidence of heterogeneity with respect to how people respond to contextual changes. Alatas et al. (2009) conclude that expert subjects find contextual framing more useful than students, leading to the conclusion that framing effects in student subject pools might have been underestimated so far.

We aim to close the gap in the literature and to reduce inconsistencies by including contextual framing and personal involvement in the risk elicitation research design. More specifically, we show in this paper that risk preference elicitation methods evoke fewer between-method and within-method inconsistencies when specific task and context involvement is included in the analysis. In our analysis, task involvement is determined by the decision makers' task related effort. In contrast, context involvement is defined by the personal relevance of the task for the decision maker.

The remainder of this paper is organized as follows. First, we give an overview on the existing literature concerning risk preference elicitation and inconsistencies. Next, an introduction to the experimental design and methodology used in this analysis is presented. The subsequent description of the data sample and results of this research is followed by the conclusion.

2.2 Literature background

Over the last decade approximately 20 new methods to elicit risk preferences have been published (for a detailed overview on the most established ones see Charness, Gneezy, and Imas, 2013). Along these lines, there is growing literature on comparing experimental methods to measure risk preferences (e.g. Coppola, 2014, Csermely and Rabas, 2017, Crosetto and Filippin, 2015).

The most prevalent method to elicit risk preferences is via a Multiple Price List (MPL), where subjects are presented with a series of choices between gambles. This approach allows to estimate intervals for the curvature parameters of a utility function for each subject. However, since the inference of risk preferences, and in turn, parameter estimation, requires a unique switching point respondents with more than one switching point are not behaving consistently under standard EUT assumptions on preferences (Charness et al. 2013). The problem of inconsistencies in MPL tasks is highly relevant in empirical research on experimental risk preference elicitation methods. For instance, Charness and Viceisza (2016) found that 75% of Senegalese farmers made inconsistent choices, Hirschauer et al. (2014) found 57% inconsistent answers amongst Kazakh farmers, and, using a sample of adults in Ruanda, Jacobson and Petrie (2009) found an inconsistency rate of 55%. High inconsistency rates are also observed in developed countries: e.g. Lévy-Garboua et al. (2012) find that on average around 36% of French students behave inconsistently in different MPL settings, Holt and Laury (2002) find 13% inconsistent answers amongst students in the USA and Dave et al. (2010) find 8.5% of participants answering inconsistently in a sample of Canadian citizens. The main problem of data containing inconsistencies is related to the different ways of dealing with inconsistencies to interpret risk preferences. Most researchers choose to either ignore subjects with inconsistent choices or to make specialized assumptions on the nature of stochastic errors and estimate the parameters of interest (Jacobson and Petrie, 2009). Excluding inconsistently behaving subjects, results in a biased sample since systematic differences may exist in the risk preferences of consistent and inconsistent participants (see Jacobson and Petrie (2009) for more details on behavioral patterns of subjects making mistakes). When including inconsistently responding subjects in the estimation of the risk aversion parameter, a stochastic error term (i.e. 'structural noise') parameter is often included in the estimation (see e.g. Harrison and Rutström, 2008, Carbone and Hey, 2000).

Three driving factors explaining between- and within-method instability of risk preference elicitation have been identified in the literature: i) differences in the cognitive ability of subjects and task complexity (Lévy-Garboua et al., 2012, Anderson and Mellor, 2009, Dave et al., 2010), ii) misspecification of individual preferences (Harrison, Lau, and Rutström, 2007, Starmer, 2000) and iii) context-dependence of risk preferences (Holt and Laury, 2005, 2002, Deck, Lee, and Reyes, 2014).

One way to overcome problems with inconsistencies stemming from the subject pools cognitive abilities or complexity of the task is to use simpler risk preference elicitation methods. Dave et al. (2010) perform experiments on subjects with different mathematical ability. They conclude that a simpler elicitation method results in higher within-method consistency for subjects with lower mathematical ability. However, simpler alternative risk elicitation methods imply a loss of comparability and accuracy. Furthermore, Bruner (2009) and Lévy-Garboua et al. (2012) explore how different ways of displaying the choice sets affect inconsistency rates. Bruner (2009) finds less within-method inconsistencies for a menu displayed lottery frame with increasing probabilities vs. increasing reward. Levin, Schneider, and Gaeth (1998) find more inconsistent behavior with a sequential and increasing presentation of the MPL compared to a random probability presentation. Based on these results, Lévy-Garboua et al. (2012) conclude that inconsistencies with a bad frame, in terms of visual presentation of the MPL, are driven by a lack of information. In a similar vein, Andersen et al. (2008) find cognitively more challenging tasks (risk preference vs. time preference elicitation), to induce more noise in the estimated parameter.

To overcome inconsistencies, due to misspecifications in the underlying theoretical model. Some include elements of prospect theory e.g. loss aversion and probability weighting to characterize risk attitudes (for a detailed comparison of different underlying theoretical concepts see Abdellaoui, Driouchi, and L'Haridon, 2011). Other authors interpret inconsistencies as indifferences and hence adapt the original design of the MPL i) by including a third choice in each row indicating indifference in preference between both lotteries (Andersen et al., 2008) or ii) by enforcing a unique switching point (see Harrison, Lau, and Rutström, 2007, Andersen et al., 2006). The latter imposes strict monotonicity on revealed preferences and enforces transitivity. As there is no further control mechanism to ascertain whether all participants understood the task, this might cause biases of the results and, in turn, biases of the estimated preferences.

Moreover, inconsistencies have been found to be context and stake dependent. For instance, Holt and Laury (2002); (2005) find that inconsistencies can be reduced by increasing the payoff level. The importance of the effect of decision frames on risk preferences has been widely recognized in the literature on decision making analysis (Levin, Schneider, and Gaeth, 1998, Tversky and Kahneman, 1986). Specifically, Deck, Lee, and Reyes (2014) find that fewer inconsistencies occur if the MPL is framed as financial investment task compared to a lottery task. They, however, used a very general setting without accounting for the specific background of the participants. Thus, we aim to extend the existing literature by focusing on the role of the subjects' contextual and task involvement when analyzing inconsistencies and the effects of different decision frames.

Based on McElroy and Seta (2003), we define task involvement as the personal effort, motivation and capacity to perform the task at hand (we use the time spent on a specific task as proxy). Context involvement is defined as the personal relevance of the task for the decision maker (we use an involvement score based on the student's involvement with the agricultural domain to measure context involvement). McElroy and Seta (2003) assume increasing task involvement with increasing context involvement, or more specifically the motivation and capacity to solve a problem is expected to increase with increasing personal relevance of the problem at hand. Furthermore, they differentiate two ways of processing decision problems[2] arising from different levels of task and context involvement of the decision maker. In particular, McElroy and Seta (2003) find that holistic/heuristic processing occurs with low levels of motivation or capacity to solve a problem. Analytic/systematic thinking

[2] Their approach follows lines of earlier research see e.g. Stanovich and West (1999) and Tversky and Kahneman (1986).

in turn sets in when the subject's motivation and ability are high[3]. Moreover, they conclude that with increasing relevance of the decision, the amount of effort expended on the task increases as well as the likelihood of analytic/systematic thinking. Subjects with a higher likelihood of exhibiting an analytic/systematic processing style are found to be more insensitive to the influence of framing effects.

However, this finding has not yet been considered in the approaches to reduce inconsistent behavior. Thus, we hypothesize that this is even more relevant if the investment task is placed in a subject specific setting. More specifically, we focus on agricultural students and formulate the financial investment task as agricultural investment decision to be taken by the participants. Furthermore, we measure the degree of context involvement in agricultural activities for each participant and test the influence of context involvement on consistency. Given the relevance of both between-method and within-method consistency (Csermely and Rabas, 2017), we aim to address both problems in our analysis. To this end, we consider "within-method consistency" i.e. consistent behavior within the MPL at one point in time and "between-method consistency" i.e. consistent behavior in different elicitation methods. We use the subject's task involvement (i.e. time spent on the risk elicitation task) to test the influence on within-method inconsistencies. We hypothesize that both: within- and between method consistency increases with increasing task and context involvement.

[3] Kahneman (2003) uses the terms system 1 thinking and system 2 thinking.

Furthermore, we use two different frames of the MPL to test the influence of contextualization on the consistent behavior between different risk preference elicitation methods (MPL and self-assessment). Following earlier studies e.g. Anderson and Mellor (2009), Charness and Viceisza (2016), Dohmen et al. (2011) and Thoma (2015), we compare risk preferences elicited using incentivized methods (MPL) and not incentivized methods (self-assessment).

2.3 Experimental design and methodology

We focus on a homogeneous sample of students to reduce the influence of factors not controlled for in the study. More specially, we conducted the survey with agricultural science students at the two largest agricultural departments in the state of North-Rhine Westphalia (Germany), i.e. the University of Bonn and the South Westphalian University of Applied Sciences[4]. All students in agricultural sciences in both universities were invited to participate in two identical online surveys conducted in January and March 2015, respectively. We aligned the list of participating students with the university administrative offices' database, ensuring that the individual student e-mail address used to complete the survey corresponds to students enrolled in agricultural studies. Students participating without being enrolled in agricultural studies at the time the survey was realized are excluded from further analysis[5]. The experiment was conducted in two parts. Part I consisted of two risk-aversion tasks as

[4] About 1,100 and 500 students are enrolled in agricultural sciences are enrolled in both faculties, respectively.

[5] There is no information on students who did not select to participate but we expect selection biases to be small because we targeted a very homogenous group of students.

explained in more detail in the following and part II consisted of a questionnaire collecting subjects' socio-demographic characteristics. Specifically, we collected information on age, sex, optimism and mothers' highest educational degree and risk literacy. For the latter, we used the Berlin numeracy test described in Cokely et al. (2012). Additionally we included in this section specific characteristics to measure the students' context involvement (i.e. growing up on a farm holding, parents are farmers, planned succession of a farm, type and length of specific agricultural education). We also tested the effects of these characteristics on risk aversion, but do not find significant effects, which is in line with similar research (e.g. Deck, Lee, and Reyes, 2014). This inexistence of significant effects of participants' characteristics is expected to be caused by the very homogenous sample used in this study. The results are not presented here but are available upon request from the authors. We measured the time each participant spent on each part of the questionnaire and use the time spent on the iterative Multiple Price List (iMPL) as proxy for task involvement.

To elicit risk preferences we use two methods dominant in the literature: a self-assessment of general risk preferences, and an iterative Multiple Price List (iMPL), an extension of the MPL. We include two different decision frames in our experiment, i.e. two different wordings that change the contextual setting of the iMPL. Additionally, we randomly changed the order of the two risk preference elicitation methods (self-assessment and iMPL). By using a random design assigning each participant only one frame, we aim to control for potential biases arising from the sequence of tasks. The instructions to the risk elicitation tasks presented to the subjects are available in Appendix 2.B[6].

2.3.1 The self-assessment of risk preferences

The self-assessment of general risk preferences is consistent with several other researchers' applications a 11-point Likert scale (Thoma, 2015, Dohmen et al., 2011, Charness and Viceisza, 2016). The exact wording is taken from the German Socio-Economic Panel Study (SOEP), which is (translated from German) as follows: "How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value 0 means: `not at all willing to take risks' and the value 10 means: `very willing to take risks'." (Wagner, Frick, and Schupp, 2007).

2.3.2 The iterative Multiple Price List

The iterative Multiple Price List (iMPL) is an extension of the basic MPL developed by Harrison, Lau, and Rutström (2007). It elicits risk preferences, resulting in a more refined description of the subjects risk preferences compared to the standard MPL. The standard MPL as introduced by Holt and Laury (2002) is structured as follows: The table has ten rows and two columns; in each row the subjects face two gambling choices A and B. Table 2.1 illustrates the basic payoff matrix presented to the subjects. Note that only the left side of the table is shown to the participants (i.e. not showing

[6] Further insights on the data are available in the Data in Brief paper accompanying this article (Meraner, Musshoff and Finger, submitted), the full survey is available in German upon request.

the expected value of option A and B, the difference of expected values and the constant relative risk aversion (CRRA) interval). The subjects are asked to choose either A or B in each row. The intuition behind this test for risk aversion is that only very risk-loving subjects would take option B in the first row, and only very risk-averse subjects would take option A in the second-last row. The last row has no relevance for risk aversion, and is simply a test that the subject understood the instructions. Only choosing option B is a rational choice, independent of the level of risk aversion. A risk-neutral subject should switch from choosing A to B when the difference of expected values A (EVA) and B (EVB) is the smallest (see right side of Table 2.1), so a risk-neutral subject would choose A for the first four rows and B thereafter.

Table 2.1: Standard payoff table MPL

Option A		Option B		EVA[a)]	EVB[a)]	Difference[a)]	Open CRRA interval[a) b)]
p(40€)	p(32€)	p(77€)	p(2€)				
10%	90%	10%	90%	32.80	9.50	23.30	$r < -1.71$
20%	80%	20%	80%	33.60	17.00	16.60	$-1.71 < r \leq -0.95$
30%	70%	30%	70%	34.40	24.50	9.90	$-0.96 < r \leq -0.49$
40%	60%	40%	60%	35.20	32.00	3.20	$-0.50 < r \leq -0.14$
50%	50%	50%	50%	36.00	39.50	-3.50	$-0.15 < r \leq 0.15$
60%	40%	60%	40%	36.80	47.00	-10.20	$0.16 < r \leq 0.41$
70%	30%	70%	30%	37.60	54.50	-16.90	$0.42 < r \leq 0.68$
80%	20%	80%	20%	38.40	62.00	-23.60	$0.69 < r \leq 0.97$
90%	10%	90%	10%	39.20	69.50	-30.30	$0.98 < r \leq 1.37$
100%	0%	100%	0%	40.00	77.00	-37.00	$r > 1.37$

Source: Own depiction according to Holt and Laury (2002) and Harrison, Lau, and Rutström (2007). Note: all currency units are in EURO at the time of the experiment 1 USD = 0.86 EURO. Note that the returns have been scaled up by a thousand tokens. a) Not shown to participants; b) Assuming a power utility function $U(x) = (1-r)^{-1} x^{1-r}$.

To analyze the data obtained in terms of coefficients of risk aversion we assume under EUT the subjects' utility function to have the following CRRA form:

$U(x) = (1-r)^{-1} x^{1-r}$, where x is the lottery price (investment return) and $r \neq 1$ the parameter of risk aversion to be estimated. With this functional form, $r = 0$ denotes risk-neutral behavior, $r > 0$ denotes risk aversion, and $r < 0$ denotes risk-loving behavior. By minimizing the difference in expected utilities obtained from option A and option B we can calibrate the open CRRA interval in the last column of Table 2.1[7]. In the iMPL the subjects are presented a second table with probabilities altering in-between the switching point of the first basic MPL. Hence, all participants are presented a maximum of twenty choices i.e. two tables with ten rows each. Assume, for example, that a subject switches in the first table in the third row from A to B (note that this is the same as to say the subject has chosen two safe choices). This choices result in a risk aversion coefficient within the interval between -0.96 and -0.49 in the first table, i.e. is risk loving. The second table that is shown to the participant would then consist of ten rows and two choices A and B with increasing probabilities ranging from 21% to 30% for option A and 79% to 70% for option B, respectively. When adding the second table and assuming the switching point is here also at row three, the risk aversion coefficient interval is narrowed down and is now located within the interval between -0.84 and -0.79[8]. To analyze the subject's degree of risk aversion we follow Harrison, Lau, and Rutström (2007) and calculate the mid-point of the CRRA interval. Consequently the iMPL, compared to the standard MPL, allows a richer characterization of the utility function and thus a more refined elicitation of the true risk attitude (Harrison, Lau, and Rutström, 2007).

[7] Note that these CRRA intervals are the same as reported by Holt and Laury (2002) (Table 3).
[8] The full table of resulting CRRA intervals is available upon request from the authors.

In order to estimate the individuals' parameter of risk aversion we are essentially estimating the likelihood to switch from option A to option B in each row. The stochastic choice process specifies the likelihood of choosing one option given an alternative option (for refinements on stochastic choice processes see Harrison and Rutström, 2008). Under EUT the expected utility of each outcome *k* in each lottery *i* is the probability weighted utility of each outcome in each lottery: $EU_i=\sum_{k=1,K}(p_k \times U_k)$, with p_k being the probabilities for each outcome. Following Abdellaoui, Driouchi, and L'Haridon (2011); Andersen et al. (2008) and Holt and Laury (2002) we use the Luce error[9] specification to estimate the likelihoods conditional on the model: $\nabla EU=EU_B^{(1/\mu)}/(EU_A^{(1/\mu)}+EU_B^{(1/\mu)})$, where EU_A is the expected utility for 'Option A', EU_B is the expected utility for 'Option B' and μ is a structural noise parameter. This enables us to include individuals' choices that are not consistent with standard EUT assumptions when estimating *r*. The log-likelihood of the risk aversion response, conditional on the EUT and CRRA specifications being true, depends on the estimates of *r* and *μ*. The likelihood of risk aversion can be written as $\ln L(r,\mu;y,X)=\sum_i((\ln(\nabla EU|y_i=1)+(\ln(1-\nabla EU|y_i=-1))$, where $yi = 1\ (-1)$ denotes the choice of the option B (A) in risk aversion task *i* and *X* is a vector of individual characteristics.

Following Harrison, Lau, and Rutström (2007) the iMPL uses the same incentive logic as the MPL. The participants were asked prior to the iMPL to answer a control question about the payoff procedure, which ensures that all participants

[9] See Harrison and Rutström (2008) for refinements on stochastic choice processes as well as a detailed comparison of Fechner and Luce error specification.

understood the payoff structure and in turn incentive compatibility of the iMPL. For 10% of all participants one row is chosen randomly from the first table to be relevant for payoff. Depending on the subjects choices and a randomly chosen number between 1 and 100 (reflecting the probabilities of payoff for option A and B) the individual payoff is determined. If the row chosen at random is not the row where the subject switched from A to B the payoff determining process ends here (identical to the MPL payoff procedure). If the row chosen is the row that the subject switched at, another random draw is made to pick a row in the second table that the subject was presented with. The subject's choice in the second drawn row is then relevant for payoff and the procedure to determine the payoff is the same as described above[10]. At the end of the experiment, for 10% of the subjects, one choice was randomly selected to be played out for real[11]. According to Baltussen et al. (2012) this between-subjects random incentive system, reduces the probability of real payoff for every task, possibly inducing lower task motivation. However, we opted for this incentive system because it allows higher prizes to be awarded to the subjects selected, which may improve motivation and reduces the high administrative costs related to paying each participant

[10] Participating students were asked to leave their unique university e-mail address enabling the researcher to contact them for the payoff. The random draws of winners and corresponding rows where carried out immediately after the participation deadline (average two weeks period). The winners were invited to pick up their prices in the faculty library, in cases when this was not possible payments where contacted and asked for further details to arrange a transfer of the prize to the student's bank account.

[11] The expected return for each participant is 4 € for approximately 20 minutes time spent on the survey. The average hourly wage rate of students employed as assistants at University amounts to 8.50 €, which is used as a reference for opportunity cost of participation. Consequently, the expected return of participating exceeds the opportunity cost, leading to an incentive compatible iMPL.

in a large online survey[12]. Additionally, this payoff structure is adopted by several researcher in the field like Maart-Noelck and Musshoff (2013) and Vollmer, Hermann, and Musshoff (2017).

2.4 Inconsistencies and contextualization

Different ways of inconsistent behavior, that is behavior not consistent with assumptions made in EUT, within the above presented iMPL are possible: i) inconsistent response behavior is revealed if more than one switching point between option A and B is observed; ii) inconsistent behavior is indicated by “backwards” choices, i.e. switching in the other direction from option B in the first row to option A in the following rows (Lévy-Garboua et al., 2012, Holt and Laury, 2002) and iii) as the last set of choices is commonly a control question with option B clearly dominating option A, a subject choosing A in all 10 rows is also thought of behaving inconsistent. Because in the last row option B results with certainty in a higher payoff than option A (see also Table 2.1 for an example). Note that in the iMPL there is a possibility of inconsistent behavior either in the first or in the second table. Both cases are in the following treated as within-method inconsistencies.

Based on the findings of Lévy-Garboua et al. (2012) and Holt and Laury (2002) we avoid excessively high inconsistency rates by showing probabilities simultaneously (i.e. the full table of choices at once) and using high payoff. The payoff are identical to the high payoff treatment of Holt and Laury (2002), this is the original

[12] See Baltussen et al. (2012) for an in depth discussion on the application of different incentive systems.

lottery payoff X 20. Note that in order to construct a realistic agricultural decision the returns in both frames (general lottery and agricultural decision) have been scaled up by thousand. The participants were informed about the exchange value for the real payoff in the control question prior to the iMPL.

We use two different contextual settings of the iMPL to analyze the effects of involvement. They are as follows: First, the traditional wording according to Holt and Laury (2002) of a gambling choice between two lotteries A and B with different payoff and associated probabilities. In the further this is referred to as 'general lottery' frame[13]. Second an agricultural decision with investment options A and B with different returns and associated probabilities. This is in the further referred to as the 'agricultural decision' frame. Note that no time components have been included in the task or task description. In contrast, it was very clear to the participants that payoffs are made shortly after the experiment was conducted (for both tasks). Two pre-test sessions with 19 students did neither reveal difficulties with respect to the experiments payoff structure or framing, nor indicated a misunderstanding regarding the time dimension of the agricultural investment decision. Thus, there is no evidence for time related biases in the agricultural investment frame (Deck, Lee, and Reyes, 2014). Nevertheless, investment decisions are undoubtedly closer to the real decisions subjects face in there every day life, justifying the chosen comparison. The specific application to agriculture makes use of the educational background of the participants.

[13] The exact wording of the general lottery task is as following: "In each row of the following table you can choose between two lotteries (A and B). With certain chances/ probabilities you get for lottery A a payoff of 40.000 € or 32.000 € and for lottery B a payoff of 77.000 € or 2.000 €. Please decide between lottery A and B for every row of the table."

The wording of the agriculture specific question reads as following: "Assume that after successful completion of your studies you are offered to make an agricultural investment. Here you will get with different associated probabilities for investment A a return of 40,000 € or 32,000 € and for investment B a return of 77,000 € or 2,000 €. You can choose in the following table in each row between the two investment options (A or B)."

In order to analyze the effect of task involvement on within-method consistency we compare the frequencies of inconsistent answers in the different iMPL frames depending on the individual task involvement. Additionally, we compare the structural noise μ when estimating the risk preference parameter r for both frames and differences in context involvement using standard maximum likelihood procedures (following Harrison and Rutström, 2008).

To analyze whether between-method consistency increases with increasing context involvement we compare the correlation of risk aversion coefficients compiled using the two elicitation methods described above (iMPL and self-assessment[14]). Using the methodological steps suggested by Olkin and Finn (1995) and Steiger (1980), we compare the correlation of both risk elicitation methods in the two iMPL frames. The same approach is used to test if task involvement influences between-method consistency.

[14] To account for the ordinal structure of responses from Likert scale questions, we use rank correlations throughput the entire paper.

2.5 Sample description and results

We obtained 370 answers and 156 complete questionnaires from Bonn University and 194 answers with 96 complete questionnaires from the South Westphalian University of Applied Sciences leading to a total of 252 complete questionnaires (response rate of 34% and 15% complete responses). After the data cleansing process 244 surveys remained[15]. Due to strict data protection policies in both universities, only information on the agricultural students' gender was available. At Bonn University 43% male and 57% female agricultural students are enrolled, this is reflected in our sample. The consistent answers amount to 195. Among them, 95 were randomly assigned to the general lottery and 100 students were randomly assigned to the agricultural decision. Table 2.2 shows the summary statistics for the total sample, and Table 2.3 shows the summary statistics by the general lottery and the agricultural decision sample separately.

The mean CRRA interval mid-point indicates an average risk aversion coefficient of 0.57, which is in line with other researchers' findings (see Harrison, Lau, and Rutström, 2007). Furthermore, the self-assessment of the participants risk attitude is with an average of 4.64 also pointing towards risk aversion. Context involvement is defined as the personal relevance of the task for the decision maker. We calculate a context involvement score based on the student's agricultural involvement (referring to the specific agricultural contextualization used). This score includes the following

[15] Participants not enrolled in agricultural studies and non-German students were excluded to eliminate biases due to different educational and cultural differences we are not accounting for.

factors: rural origin, farm upbringing, parents are farmers, succession of farm holding intended, agricultural internship, vocational training, and obtained agricultural education certificate. The average context involvement score is 1.74 points. The average task involvement measured by the time spent on the iMPL is 3.40 minutes, and the time spent on the self-assessment of risk preferences 0.43 minutes (see Table 2.2 for summary statistics of variables, a detailed description of variables can be found in Appendix A.2 Table 2.A.1). When comparing the sample with the general lottery framing and contextualized lottery we see lower average risk aversion in the general lottery framed iMPL. Context involvement scores are on average higher in the sample randomly assigned to the contextualized iMPL[16] (see Table 2.3).

Table 2.2: Summary statistics by within-method consistency

	Total sample								
				Within-method consistent			Within-method inconsistent		
	N=244			N=195			N=49		
	mean	sd	NA	mean	sd	NA	mean	sd	NA
Self-assessment	4.65	2.66		4.54	2.61		5.08	2.83	
CRRA interval mid-point	0.53	0.70	5	0.61	0.55		0.15	1.09	5
Risk literacy	2.85	1.16		2.94	1.14		2.49	1.21	
Gender (female)	0.49	0.50		0.50	0.50		0.47	0.50	
Optimism	0.69	1.24		0.72	1.20		0.55	1.37	
Age	24.80	2.54		24.82	2.55		24.71	2.53	
Education mother	4.56	1.88	5	4.69	1.90	4	4.04	1.69	1
Context involvement score	1.74	1.83		1.65	1.81		2.08	1.87	
Time iMPL	3.40	2.63		3.53	2.32		2.88	3.60	
Time self-assessment	0.43	0.62		0.50	0.77		0.29	0.16	

[16] We have further estimated a binary logit model using demographic characteristics of participants as independent variables and inconsistent behavior as dependent variable. However, this analysis did not result in statistically significant coefficient estimates (results are available upon request).

Table 2.3: Summary statistics by frame and within method consistency

	General lottery frame									Agricultural decision frame								
				Within-method consistent			Within-method inconsistent						Within-method consistent			Within-method inconsistent		
	N=127			N=95			N=32			N=117			N=100			N=17		
	mean	sd	NA	mean	sd	NA	mean	sd	NA	mean	sd	NA	mean	sd	NA	mean	sd	NA
Self-assessment	4.64	2.70		4.59	2.72		4.78	2.70		4.66	2.63		4.49	2.53		5.65	3.06	
CRRA interval mid-point	0.48	0.79	2	0.63	0.51		0.00	1.23	3	0.57	0.58	3	0.59	0.58		0.46	0.62	3
Risk literacy	2.89	1.18		3.04	1.16		2.44	1.13		2.80	1.15		2.84	1.12		2.59	1.37	
Gender (female)	0.51	0.50		0.53	0.50		0.47	0.51		0.47	0.50		0.47	0.50		0.47	0.51	
Optimism	0.68	1.23		0.72	1.23		0.56	1.22		0.70	1.25		0.73	1.18		0.53	1.66	
Age	24.69	2.58		24.73	2.52		24.56	2.78		24.91	2.51		24.90	2.59		25.00	2.03	
Education mother	4.41	1.86	3	4.62	1.91	2	3.77	1.54		4.71	1.89	2	4.74	1.90	2	4.53	1.87	
Context involvement score	1.58	1.67		1.52	1.61		1.77	1.85		1.90	1.98		1.77	1.98		2.68	1.79	
Time iMPL	3.04	1.98		3.28	2.12		2.33	1.29		3.79	3.15		3.77	2.49		3.91	5.82	
Time self-assessment	0.45	0.66		0.49	0.73		0.31	0.15		0.49	0.77		0.51	0.81		0.27	0.18	

In order to analyze the effect of task and context involvement on within-method consistency we first compare the frequencies of inconsistent answers in the different iMPL frames (see Table 2.4). A total of 49 students (20%) answered inconsistently. This is comparable to inconsistency rates found among student samples by Lévy-Garboua et al. (2012) (36%) and Holt and Laury (2002) (13%). We group the students into a "high task involvement" group and a "low task involvement" group according to the time they needed to complete the iMPL. The cut-off value is the median time needed by the whole sample to complete the task. We see clearly more cases of inconsistent behavior in the group of students with low task involvement (28%). In the high task involvement group only 12% behave inconsistently. The null hypothesis of independence of consistence of answers and task involvement can be rejected at the 1% level of significance.

Table 2.4: Contingency table of inconsistencies by task involvement

	Consistent	**Inconsistent**	**Row total**	**2nd table inconsistent**
High task involvement	107	15	122	6
Chi-square contribution	0.928	3.684		
% of total row	88%	12%		40%
Low task involvement	88	34	122	15
Chi-square contribution	0.926	3.684		
% of total row	72%	28%		48%
Column total	195	49	244	
Pearson's Chi-squared test with Yates' continuity correction = 8.2738				
p-value = 0.004				

We did not measure the time expended on the first and second table of the iMPL separately. Thus, it is important to note that 48% of the inconsistent subjects in the low involvement group and 40% of the inconsistent subjects in the high involvement group behaved inconsistently in the second table. Consequently, the bias in time measurement caused by the two.

In addition, we analyze the influence of context involvement on within-method consistency (see Table 2.5). We see more cases of inconsistent answers in the general lottery frame (25%) than in the agricultural decision frame (15%). This result is slightly significant (i.e. at the 5.5% level)[17], revealing a pattern of different inconsistency rates related to the different iMPL frames. Our approach differs from earlier work, e.g. by Deck, Lee, and Reyes (2014), by placing the agricultural decision task in a subject specific setting. Based on this further specification of the framing, we can show that within-method consistency increases with context involvement.

Table 2.5: Contingency table of inconsistencies by context involvement

	Consistent	**Inconsistent**	**Row total**
General lottery	95	32	127
Chi-square contribution	0.416	1.655	
% of total row	75%	25%	52%
Agricultural decision	100	17	117
Chi-square contribution	0.451	1.796	
% of total row	86%	15%	48%
Column total	195	49	244

Pearson's Chi-squared test with Yates' continuity correction = 3.6784
p-value = 0.055

Furthermore, we analyze maximum likelihood estimates of the individual risk aversion coefficient r and the Luce noise parameter μ from our experiments. In this

[17] The same pattern is observed if analyzing the samples from both universities individually. Results at Bonn University show a highly significant difference (at the 5% level), while the results from the South Westphalia University of Applied Sciences do not.

analysis, we also include the participants' agricultural context involvement (see Table 2.6). Our estimates in both frames show that there is significant noise within both frames. However, there is a larger estimated noise for the general lottery task than the agricultural decision task. Additionally, there are larger estimates of noise for students with a lower than average context involvement. This is consistent with our prior that the general lottery task relates less to the subjects' real world decision making process and in turn triggers less analytic/systematic thinking.

Table 2.6: Estimates of risk aversion and Luce structural noise parameter in different iMPL frames

		Estimate	**Standard error**	**95% confidence interval**
General lottery				
High context involvement				
	r	0.595	0.123	0.354 - 0.835
	μ	0.048	0.022	0.004 - 0.091
Low context involvement				
	r	0.668	0.274	0.130 - 1.205
	μ	0.004	0.127	-0.244 - 0.252
Agricultural decision				
High context involvement				
	r	0.407	0.098	0.215 - 0.598
	μ	0.055	0.011	0.033 - 0.077
Low context involvement				
	r	0.661	0.066	0.531 - 0.790
	μ	0.019	0.035	-0.050 - 0.088

Note that for this estimation only the first switching point in the first table considered. r reflects the estimated risk preference parameter and μ the estimated structural noise.

Consequently our findings support the hypothesis that within-method consistency increases with increasing task and context involvement.

When analyzing between-method inconsistencies first we examine the correlations of both risk elicitation methods in the two frames (note that we include only within-method consistently behaving subjects in this analysis). Table 2.7 shows that for both frames of the iMPL the correlation coefficient with the result of the self-assessment task is negative. Thus, herein both risk elicitation tasks point towards the same risk preference direction. Recall that resulting from the structure of both elicitation methods a lower value in the self-assessment and a higher value in the iMPL indicate risk aversion. However, the correlation of the risk preferences derived in the general lottery sample and the self-assessment task (-0.090) and the correlation of the risk preferences derived in the agricultural decision sample and the self-assessment task (-0.028) do not significantly differ from each other. Therefore, we reject the hypothesis that both correlations obtained from independent samples are different.

Table 2.7: Spearman's rank correlations between CRRA interval mid-points in different iMPL frames and self-assessment

	r_s
General lottery	-0.090
Agricultural decision	-0.028
Fishers' z-value	0.43
p-value	0.64

To test if between-method consistency is driven by the effort spent on the risk elicitation tasks we include the subjects' task involvement in our analysis of between-method inconsistencies. As described above, we split our sample in two independent groups with low and high task involvement. Here we distinguish the two groups by the median of the total time spent on both risk elicitation methods. The correlation of the risk aversion coefficients of the group with low task involvement is positive but not significant (+0.037). Thus, here both risk preference parameters are not consistently measuring risk averse or risk loving preferences, i.e. there are more between-method inconsistencies in this group. In the group with high task involvement we find contrary results. The risk aversion coefficients are here negative correlated (-0.182) at a 10% significance level, i.e. both risk preference parameter point towards the same direction in this group. Between-method inconsistency is here significantly lower. We cannot reject the hypothesis that both correlation coefficients obtained from independent samples are different. We find a statistically significant difference of the correlation of the CRRA mid-point and self-assessment for students with higher task involvement (see left column in Table 2.8).

Table 2.8: Spearman's rank correlations between CRRA interval mid-points in different iMPL frames and self-assessment for different levels of task involvement

	Total sample	**General lottery**	**Agricultural decision**
High task involvement	-0.182*	-0.321**	-0.064
Low task involvement	0.037	0.106	-0.002
Fishers' z-value	1.59	2.07	0.30
p-value	0.11	0.04	0.77

Note: ∗ and ∗∗ denote 10% and 5% significance levels, respectively

Furthermore, we analyze if these differences in between-method inconsistencies, depending on the individuals' task involvement, are more severe in the general lottery frame than in the agricultural decision frame. We find that in both frames the correlation coefficients of iMPL and self-assessment are negative for subjects with high task involvement. For subjects with low task involvement in the general lottery frame we find a positive correlation of the risk preference coefficients from both risk preference elicitation methods, thus although not significant there is evidence for between method inconsistency. Contrarily the correlation of the two risk preference coefficients is negative in the agricultural decision framed task, indicating less between method inconsistencies (Table 2.8). Nevertheless, we find that this difference in the two frames diminishes in the high task involvement group. When looking at the significance of the difference of the two independent groups (low and high task involvement) we find that it is only significant in the general lottery frame (Fishers'z value = 2.07, p-value=0.04). Between-method inconsistencies are not significantly depending on task involvement in the agricultural decision setting. Thus, if context involvement is triggered, task involvement does not influence between-method inconsistencies. Framing effects play only a minor role when analyzing between-method consistency.

2.6 Conclusion

The subjective risk attitude is decisive for a wide range of decisions taken by economic actors. Over the last decades, a wide range of approaches has been introduced to elicit subjective risk attitudes. However, these elicitation approaches are plagued by inconsistent responses by participants. High inconsistency rates can provoke biased risk preference interpretation and an unavoidable reduction of the explanatory power of the analysis. Thus, the reduction of inconsistent behavior is crucial to improve our understanding of risk preferences. We provide the first study that investigates the role of the decision maker's involvement and how this relates to contextualization of experiments. To this end, we analyze data gathered in experiments considering the subjects’ specific differences in context involvement. The methods applied comprise a self-assessment of risk preferences and an incentive-compatible iMPL.

We find evidence that subjects’ context and task involvement influence inconsistencies. More specifically, we find that within-method inconsistencies are reduced with increasing task and context involvement. In addition, between-method inconsistencies decrease with increasing task involvement. Adding the subjects’ specific contextualization of the risk elicitation method to the analysis of between-method consistency, we find that the importance of task involvement to increase between-method consistency diminishes with increasing contextual involvement. Furthermore, we find that subject specific contextualized elicitation improves accuracy. Thus, we conclude that the contextual embeddedness of a decision making problem is crucial when trying to analyze risk preferences of a specific subject group. Our study was restricted to the analysis of the influence of context and task involvement on between-method inconsistencies and on within-method inconsistencies at one point in time. Further research should also include a time dimension to test for the influence of task and context involvement on within-method inconsistency across time. Furthermore, the analysis of between- method inconsistencies can be extended by increasing the number of compared risk preference elicitation methods. Besides, changing the task wording other exogenous variations like the stake sizes, changes in the visualization of the task or changes of the prominence of the specific task in the experimental design as a whole could be used to extend findings on ways to trigger involvement. In addition to comparing differences in inconsistencies resulting from adaptations of the standard MPL further research should concentrate on comparing noise estimates for different underlying theoretical concepts. For example, noise parameters estimated based on the rank dependent utility model could be compared with the estimated noise parameter assuming EUT.

Although students are the most convenient subjects for researchers in experimental economics, there have been difficulties when trying to project students risk preferences to real decision makers (see Carpenter, Burks, and Verhoogen, 2005). We have shown that with increasing involvement students perform better in risk elicitation tasks in terms of consistency. Future research should concentrate on finding ways to trigger students' task and context involvement if they are used as a convenience group in experimental economics. Additionally, research should also concentrate on showing that risk preferences of students with higher context involvement could project risk preferences of real decision makers. In turn, this can lead to better predictions of real world decisions and thus improve policy analysis.

Finally, we have shown that by using a real life and subjective context related MPL, involvement can be triggered and consequently the problem of inconsistencies and misinterpretations caused by it can be reduced.

2.7 References

Abdellaoui, Mohammed, Ahmed Driouchi, and Olivier L'Haridon. 2011. "Risk aversion elicitation: reconciling tractability and bias minimization." *Theory and Decision* 71 (1):63-80.

Alatas, Vivi, Lisa Cameron, Ananish Chaudhuri, Nisvan Erkal, and Lata Gangadharan. 2009. "Subject pool effects in a corruption experiment: A comparison of Indonesian public servants and Indonesian students." *Experimental Economics* 12 (1):113-132.

Alekseev, Aleksandr, Gary Charness, and Uri Gneezy. 2017. "Experimental methods: When and why contextual instructions are important." *Journal of Economic Behavior & Organization* 134:48-59.

Andersen, Steffen, Glenn W Harrison, Morten Igel Lau, and E Elisabet Rutström. 2006. "Elicitation using multiple price list formats." *Experimental Economics* 9 (4):383-405.

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, and Elisabet E. Rutström. 2008. "Eliciting Risk and Time Preferences." *Econometrica: Journal of the Econometric Society* 76 (3):583-618.

Anderson, Lisa R., and Jennifer M. Mellor. 2009. "Are risk preferences stable? Comparing an experimental measure with a validated survey-based measure." *Journal of Risk and Uncertainty* 39 (2):137-160.

Baltussen, Guido, Thierry G. Post, Martijn J. van den Assem, and Peter P. Wakker. 2012. "Random incentive systems in a dynamic choice experiment." *Experimental Economics* 15 (3):418–443.

Bruner, David M. 2009. "Changing the probability versus changing the reward." *Experimental Economics* 12 (4):367-385.

Carbone, Enrica, and John D. Hey. 2000. "Which error story is best?" *Journal of Risk and Uncertainty* 20 (2):161-176.

Carpenter, Jeffrey, Stephen Burks, and Eric Verhoogen. 2005. "Comparing students to workers: The effects of social framing on behavior in distribution games." *Research in Experimental Economics* 10:261-290.

Charness, Gary, Uri Gneezy, and Alex Imas. 2013. "Experimental methods: Eliciting risk preferences." *Journal of Economic Behavior & Organization* 87:43–51.

Charness, Gary, and Angelino Viceisza. 2016. "Three Risk-elicitation Methods in the Field: Evidence from Rural Senegal." *Review of Behavioral Economics* 3 (2):145-171.

Cokely, Edward T., Mirta Galesic, Eric Schulz, Saima Ghazal, and Rocio Garcia-Retamero. 2012. "Measuring risk literacy: The Berlin numeracy test." *Judgment and Decision Making* 7 (1):25.

Coppola, Michela. 2014. "Eliciting risk-preferences in socio-economic surveys: How do different measures perform?" *The Journal of Socio-Economics* 48:1-10.

Crosetto, Paolo, and Antonio Filippin. 2015. "A theoretical and experimental appraisal of four risk elicitation methods." *Experimental Economics* 19 (3):1–29.

Csermely, Tamás, and Alexander Rabas. 2017. "How to reveal people's preferences: Comparing time consistency and predictive power of multiple price list risk elicitation methods." *Journal of Risk and Uncertainty* 53 (2):107-136.

Dave, Chetan, Catherine C. Eckel, Cathleen A. Johnson, and Christian Rojas. 2010. "Eliciting risk preferences: When is simple better?" *Journal of Risk and Uncertainty* 41 (3):219-243.

Deck, Cary, Jungmin Lee, and Javier Reyes. 2014. "Investing versus gambling: experimental evidence of multi-domain risk attitudes." *Applied Economics Letters* 21 (1):19-23.

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, and Gert G. Wagner. 2011. "Individual risk attitudes: Measurement, determinants, and behavioral consequences." *Journal of the European Economic Association* 9 (3):522–550.

Eckel, Catherine C., and Philip J. Grossman. 2002. "Sex differences and statistical stereotyping in attitudes toward financial risk." *Evolution and Human Behavior* 23 (4):281–295.

Harrison, Glenn W., Morten I. Lau, and Elisabet E. Rutström. 2007. "Estimating risk attitudes in denmark: A field experiment." *The Scandinavian Journal of Economics* 109 (2):341-368.

Harrison, Glenn W., and Elisabet E. Rutström. 2008. "Risk aversion in the laboratory." In *Risk aversion in experiments*, edited by James C. Cox and Glenn W. Harrison, 41-196. online: 08 Mar 2015: Emerald Group Publishing Limited.

Hirschauer, Norbert, Oliver Musshoff, Syster C. Maart-Noelck, and Sven Gruener. 2014. "Eliciting risk attitudes – how to avoid mean and variance bias in Holt-and-Laury lotteries." *Applied Economics Letters* 21 (1):35–38.

Holt, Charles A., and Susan K. Laury. 2002. "Risk aversion and incentive effects." *American Economic Review* 92 (5):1644–1655.

Holt, Charles A., and Susan K. Laury. 2005. "Risk aversion and incentive effects: New data without order effects." *American Economic Review*:902–904.

Jacobson, Sarah, and Ragan Petrie. 2009. "Learning from mistakes: What do inconsistent choices over risk tell us?" *Journal of Risk and Uncertainty* 38 (2):143–158.

Kahneman, Daniel. 2003. "Maps of bounded rationality: Psychology for behavioral economics." *American Economic Review* 93 (5):1449-1475.

Kahneman, Daniel, and Amos Tversky. 1979. "Prospect theory: An analysis of decision under risk." *Econometrica: Journal of the Econometric Society*:263-291.

Levin, Irwin P., Sandra L. Schneider, and Gary J. Gaeth. 1998. "All frames are not created equal: A typology and critical analysis of framing effects." *Organizational Behavior and Human Decision Processes* 76 (2):149-188.

Lévy-Garboua, Louis, Hela Maafi, David Masclet, and Antoine Terracol. 2012. "Risk aversion and framing effects." *Experimental Economics* 15 (1):128-144.

Maart-Noelck, Syster C., and Oliver Musshoff. 2013. "Measuring the risk attitude of decision-makers: are there differences between groups of methods and persons?" *Australian Journal of Agricultural and Resource Economics* 58 (3):336–352.

McElroy, Todd, and John J. Seta. 2003. "Framing effects: An analytic–holistic perspective." *Journal of Experimental Social Psychology* 39 (6):610-617.

Meraner, Manuela, Robert Finger, and Oliver Musshoff. submitted. "Using involvement to reduce inconsistencies in risk preference elicitation."

Stanovich, Keith E., and Richard F. West. 1999. "Discrepancies between normative and descriptive models of decision making and the understanding/acceptance principle." *Cognitive Psychology* 38 (3):349-385.

Starmer, Chris. 2000. "Developments in non-expected utility theory: The hunt for a descriptive theory of choice under risk." *Journal of Economic Literature* 38 (2):332-382.

Steiger, James H. 1980. "Tests for comparing elements of a correlation matrix." *Psychological Bulletin* 87 (2):245-251.

Thoma, Carmen. 2015. "Under- versus overconfidence: an experiment on how others perceive a biased self-assessment." *Experimental Economics* 19 (1):218-239.

Tversky, Amos, and Daniel Kahneman. 1986. "Rational choice and the framing of decisions." *The Journal of Business* 59 (4):251–278.

Vollmer, Elisabeth, Daniel Hermann, and Oliver Musshoff. 2017. "Is the risk attitude measured with the Holt and Laury task reflected in farmers' production risk?" *European Review of Agricultural Economics*:1-26.

Wagner, Gert G., Joachim R. Frick, and Jürgen Schupp. 2007. "The German Socio-Economic Panel Study (SOEP): Scope, Evolution and Enhancements." *Schmollers Jahrbuch* 127 (1):139–169.

Wilcox, Nathaniel T. 2008. "Stochastic models for binary discrete choice under risk: A critical primer and econometric comparison." In *Risk aversion in experiments*, edited by James C. Cox and Glenn W. Harrison, 197-292. online: 08 Mar 2015: Emerald Group Publishing Limited.

2.8 Appendix 2.A

Table 2.A.1: Variable description

Risk preference elicitation method	**Measurement description**
CRRA interval mid-point	iMPL CRRA interval mid-point
Self-assessment	0 if very risk averse; …; 10 if very risk loving
Variable Name	**Variable description**
Gender	1 if female
Age	Years
Optimism	Difference of life satisfaction in a year and life satisfaction today (both measured on a scale from 0 to 10)
Risk literacy score	1 = poor numerical reasoning; 2 = rather poor numerical reasoning; 3 = good numerical reasoning; 4 = very good numerical reasoning (according to Cokely et al., 2012)
Education mother	Mothers highest education according to the German schooling system: 1if no degree obtained;…; 9 if PhD degree obtained
Involvement score	Sum of involvement factors described below
Rural origin	0.5 if area of growing up has less than 20,000 inhabitants
Growing up on farm holding	1 if grew up on a farm
Parents are farmers	1 if parents are farmers
Succession of farm holding intended	0.5 if probably no succession is intended; 1 if probably succession is intended; 2 if succession is intended
Agricultural internship	0.5 if internship time is less or equal to 6 months; 1 if internship time is more than 6 months
Vocational training	1 if agriculture specific vocational training obtained
Agricultural school	1 if three year agricultural school degree
Master exam	1 if five year agricultural school degree (master)
Higher agricultural education	1 if higher agricultural education obtained
Time iMPL	Time spent on iMPL in minutes
Time Self-assessment	Time spent on self-assessment of risk preferences in minutes

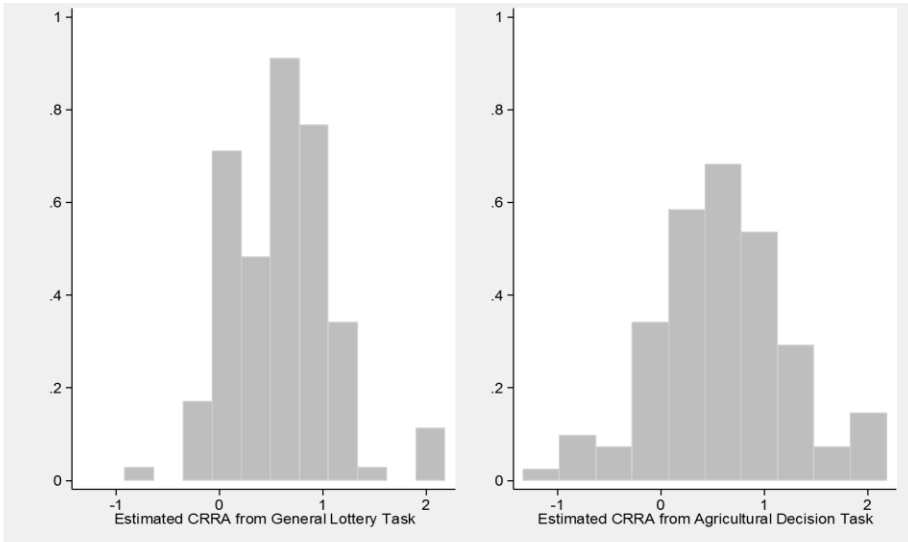


Figure 2.A.1: Distribution of the CRRA interval mid-point in two different iMPL frames

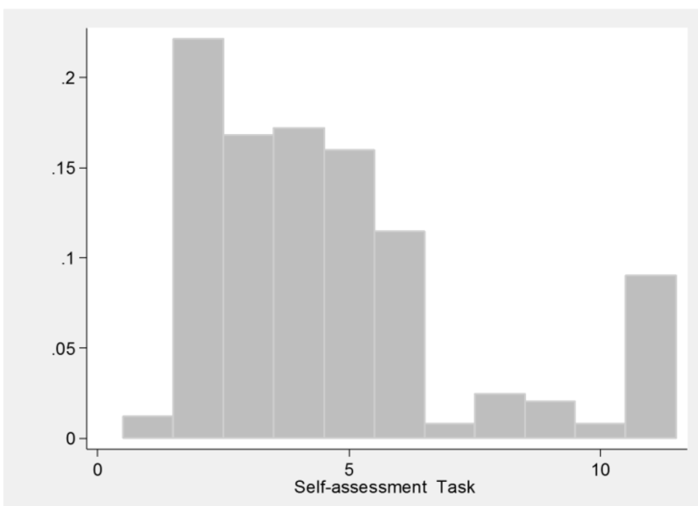


Figure 2.A.2: Distribution of self-assessment task

2.9 Appendix 2.B

First screen

Welcome to the experiment!

In the following we will offer you various situations and options to choose from. We would like to get to know something about your behavior in different situations/scenarios. <u>There are no 'right' or 'wrong' decisions!</u>

For all participants there is a chance to be drawn at random for a win of 87 €. We will inform you about your payoff via e-mail. The payoff of the win will be carried out immediately after the evaluation of the experiment.
The experiment will take approx. 20 minutes. Of course, your data will be treated confidentially and the data will be evaluated anonymously. For further inquiries please contact: m.meraner@ilr.uni-bonn.de.

Second screen
Please read carefully through the following description of your chances to win:
What can you win? The payoff for each participant can amount up to 87 € (first part: 77 € + second part: 10 €).
How can you win? In the first part of the experiment you will be presented a table with ten rows. For each row you will have to choose between option A and option B. The decision (row), that will be relevant for your payoffs, will be determined by the first draw out of a lottery with ten balls. In the case that row 4 will be identified, you were asked to choose between option A (40% probability/chance 40.000 € und 60% probability/chance 32.000 €) and option B (40% probability/chance 77.000 € and 60% probability/chance 2.000 €). Your win will be multiplied by the factor 1/1.000.
If we assume that you have chosen option B in the randomly selected row 4. In the second draw, the numbers 1 to 4 (= 40% chance) lead to a payoff of 77 €, the numbers 5-10 (= 60% chance) result in a payoff of 2 €. In the second part we will ask you to solve some arithmetic questions. For the correct answer to these tasks, the participants, who were selected as winners, receive additionally 10 €.
Who can win? 10% of all participants will be drawn at random to receive the payment.

Third screen: control question
To make sure, that you understood the method of payment for the reward of your participation, please answer the following question:
Please assume that you were drawn randomly as one of the winners. In the first draw, which serves to identify the row, that will be relevant for the payment, 4 out of 10 was drawn. This means that the decision row 4 will be relevant for your payment. Assume furthermore, that you have chosen option A in the relevant decision (marked with the blue dot in the table on the right).

The second draw results in number 7. What is the amount of your payoff?
(1.000 € in the lottery = 1 € payoff).
(Right answer not shown to participants: 32)

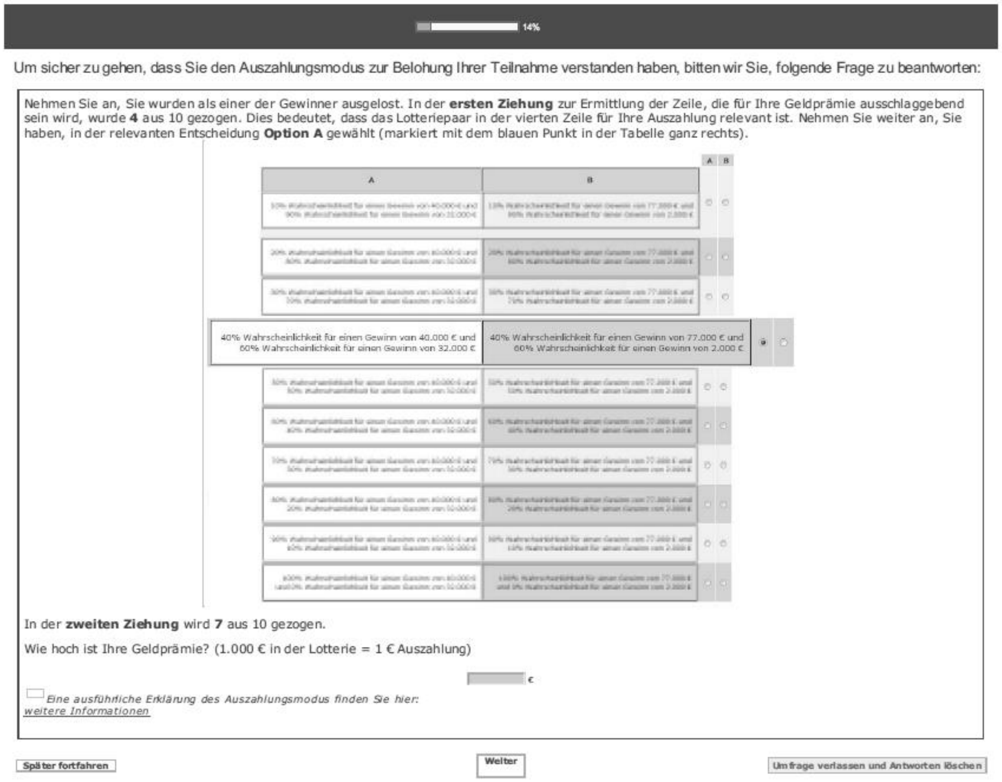


Figure 2.B.1: Third screen: control question

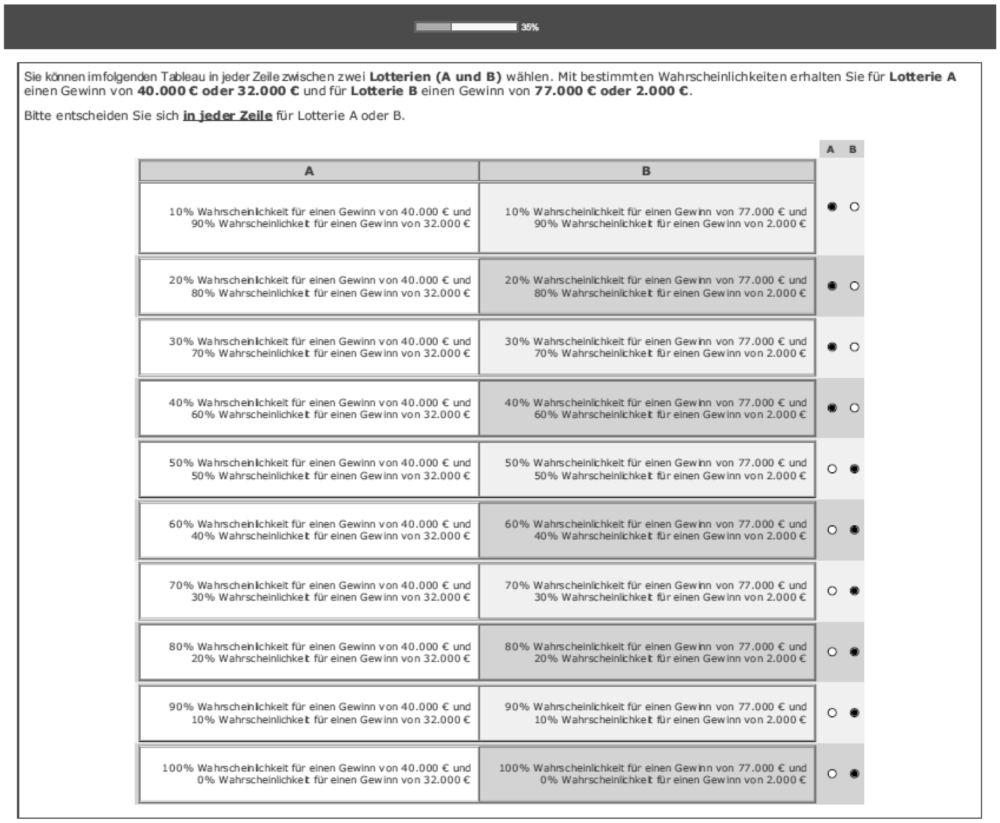
Only one of the following two screens is shown:

Fourth screen A: General lottery task

In each row of the following table you can choose between two lotteries (A and B). With certain chances/ probabilities you get for lottery A a payoff of 40.000 € or 32.000 € and for lottery B a payoff of 77.000 € or 2.000 €. Please decide between lottery A and B for every row of the table.

Fourth screen B: Agricultural decision task

Assume that after successfully completing your studies you are offered to make an agricultural investment. Here you will get with different associated probabilities for investment A a return of 40,000 € or 32,000 € and for investment B a return of 77,000 € or 2,000 €. You can choose in the following table in each row between the two investment options (A or B). Please decide between investment A and B for every row of the table.



35%

Sie können im folgenden Tableau in jeder Zeile zwischen zwei **Lotterien (A und B)** wählen. Mit bestimmten Wahrscheinlichkeiten erhalten Sie für **Lotterie A** einen Gewinn von **40.000 € oder 32.000 €** und für **Lotterie B** einen Gewinn von **77.000 € oder 2.000 €**.

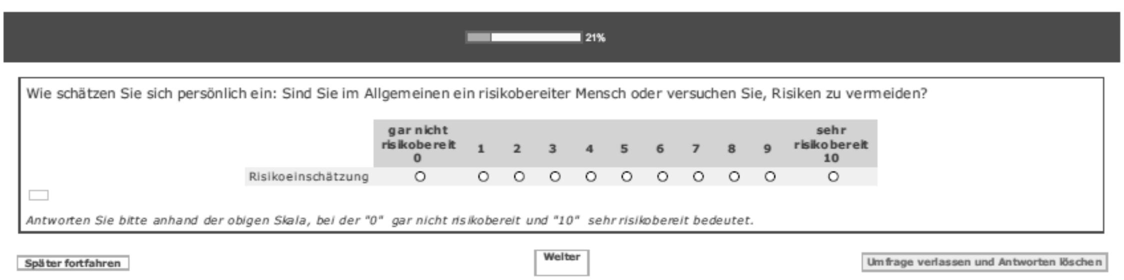
Bitte entscheiden Sie sich **in jeder Zeile** für Lotterie A oder B.

A	B
10% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 90% Wahrscheinlichkeit für einen Gewinn von 32.000 €	10% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 90% Wahrscheinlichkeit für einen Gewinn von 2.000 €
20% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 80% Wahrscheinlichkeit für einen Gewinn von 32.000 €	20% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 80% Wahrscheinlichkeit für einen Gewinn von 2.000 €
30% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 70% Wahrscheinlichkeit für einen Gewinn von 32.000 €	30% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 70% Wahrscheinlichkeit für einen Gewinn von 2.000 €
40% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 60% Wahrscheinlichkeit für einen Gewinn von 32.000 €	40% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 60% Wahrscheinlichkeit für einen Gewinn von 2.000 €
50% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 50% Wahrscheinlichkeit für einen Gewinn von 32.000 €	50% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 50% Wahrscheinlichkeit für einen Gewinn von 2.000 €
60% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 40% Wahrscheinlichkeit für einen Gewinn von 32.000 €	60% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 40% Wahrscheinlichkeit für einen Gewinn von 2.000 €
70% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 30% Wahrscheinlichkeit für einen Gewinn von 32.000 €	70% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 30% Wahrscheinlichkeit für einen Gewinn von 2.000 €
80% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 20% Wahrscheinlichkeit für einen Gewinn von 32.000 €	80% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 20% Wahrscheinlichkeit für einen Gewinn von 2.000 €
90% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 10% Wahrscheinlichkeit für einen Gewinn von 32.000 €	90% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 10% Wahrscheinlichkeit für einen Gewinn von 2.000 €
100% Wahrscheinlichkeit für einen Gewinn von 40.000 € und 0% Wahrscheinlichkeit für einen Gewinn von 32.000 €	100% Wahrscheinlichkeit für einen Gewinn von 77.000 € und 0% Wahrscheinlichkeit für einen Gewinn von 2.000 €

Figure 2.B.2: Fourth screen: General lottery task

Fifth screen: Self-assessment

How do you see yourself: are you generally a person who is fully prepared to take risks or do you try to avoid taking risks? Please tick a box on the scale, where the value 0 means: `not at all willing to take risks' and the value 10 means: `very willing to take risks'.



21%

Wie schätzen Sie sich persönlich ein: Sind Sie im Allgemeinen ein risikobereiter Mensch oder versuchen Sie, Risiken zu vermeiden?

	gar nicht risikobereit 0	1	2	3	4	5	6	7	8	9	sehr risikobereit 10
Risikoeinschätzung											

Antworten Sie bitte anhand der obigen Skala, bei der "0" gar nicht risikobereit und "10" sehr risikobereit bedeutet.

Später fortfahren

Weiter

Umfrage verlassen und Antworten löschen

Figure 2.B.3: Fifth screen: Self-assessment task

Chapter 3

Risk perceptions, preferences and management strategies: Evidence from a case study using German livestock farmers[*]

[*] Meraner, M. and R. Finger (accepted for publication at the Journal of Risk Research)

Abstract

We analyze factors affecting farmers' choice accounting for farm, farmer and household characteristics as well as elicited risk perception and risk preferences. We consider three alternative hypothetical methods for assessing risk preferences to test the stability and behavioral validity of them. Our case study focusses on livestock farmers in the German region North-Rhine-Westphalia. We find that risk preferences are context depending, i.e. differ across different fields of farm-level decision making. Furthermore, our analysis shows that risk averse farmers are more likely to prioritize on-farm risk management strategies over off-farm strategies. Moreover, higher risk perception, age, subjective numeracy, farm succession, farm size and the proportion of rented land show significant impact on farmers' risk behavior.

Keywords: risk preference elicitation, risk perception, risk management

JEL classification: D81, Q12

3.1 Introduction

In agricultural production farmers are confronted with a wide and increasing range of production, market, financial and institutional risks. Consequently, the portfolio of risk management strategies available to farmers is large and growing, but little is known about the farmer's decision-making process when choosing the optimal risk management strategies. Behavior under risk typically results from the interplay of the perceived risk level faced by decision-makers and their own preferences towards risk. In order to understand farmers' choice of risk management strategies both farmers' perception of risks and farmers' personal characteristics (including preferences towards risk) need to be considered.

The perception of risks (i.e. the perception of the economic environment) of the decision maker is widely recognized to influence the decision making process (Slovic, Fischhoff, and Lichtenstein, 1982, van Raaij, 1981). Risk perception is determined by the objective risk an individual is exposed to and the subjective interpretation of risks. Consequentially, risk perception is the combination of the probability of the occurrence of an uncertain event and the consequential negative impact (Slovic, Fischhoff, and Lichtenstein, 1982).

Accounting for risk preferences is crucial to better understand farmers' decisions. The literature on risk preference elicitation methods has grown rapidly over the last decades (see Charness, Gneezy, and Imas, 2013 for an extensive overview). Most prevalent methods are based on hypothetical or non-hypothetical lottery-choices (Eckel and Grossman, 2008, Holt and Laury, 2002, Gneezy and Potters, 1997, Crosetto and Filippin, 2013) or survey questions (Weber, Blais, and Betz, 2002, Dohmen et al., 2011, Hansson and Lagerkvist, 2012). Findings on which risk preference elicitation methods can indeed best predict real risk behavior however remain ambiguous. For example, Dohmen et al. (2011) find that a simple general self-assessing risk question is better suited to explain real world behavior than the commonly used multiple price list (MPL). Moreover, Hellerstein, Higgins, and Horowitz (2013) show for a sample of US farmers that risk preferences elicited using a MPL do not necessarily allow to explain risk management choices. Recently, Menapace, Colson, and Raffaelli (2015) found that using a contextualized MPL for risk preference elicitation pertains better to the insurance uptake of Italian farmers than the standard non contextualized MPL. Along these lines, Meuwissen, Huirne, and Hardaker (2001) have shown that a set of four contextualized business questions specific to farming eliciting farmers relative risk aversion, is correlated with risk management choices.

Literature on farmers' choice of risk management strategies is often focusing on the adoption of single activities such as insurances (Menapace, Colson, and Raffaelli, 2015, Finger and Lehmann, 2012). In reality, however, farmers use a large portfolio of different risk management strategies in order to react to different risk sources (Musser and Patrick, 2002, Meuwissen, Huirne, and Hardaker, 2001, van Winsen et al., 2014). Thus, a larger set of risk management actions and their interrelations needs to be considered based on a holistic portfolio approach. Studies that address this aspect usually consider a limited set of risk management tools such as on-farm agricultural diversification and insurance in Hellerstein, Higgins, and

Horowitz (2013), insurance and hedging in Mishra and El-Osta (2002), on-farm and off-farm diversification in McNamara and Weiss (2005) or diversification of crop portfolios and off-farm labor allocation in de Mey et al. (2016). These studies, however, have not explicitly accounted for elicited risk preferences. Moreover, studies that consider a larger set of risk management strategies often apply factor analysis to reduce the number of risk management tools included in further analysis without theory based structuring (van Winsen et al., 2014, Meuwissen, Huirne, and Hardaker, 2001, Flaten et al., 2005). This ad-hoc categorization of risk management tools leads to difficulties when comparing results of those studies. Hence, there is a lack of empirical studies addressing holistic perspectives of risk management decisions and a lack of studies investigating the power of different risk preference elicitation methods to explain the composition of risk management choices taken at the farm-level.

In this study, we fill this research gap by investigating several risk attitude elicitation methods and risk management strategies simultaneously. We consider three relatively simple, easy to implement risk elicitation instruments and test their power in pertaining to actual farmer's decisions. More specifically, we use i) a general self-assessment (SA) of risk preferences, ii) a contextualized version of the multiple price list (MPL), and iii) a set of four agriculture specific business statements (BS). We use contextualized elicitation measures in our analysis (MLP and BS) as those have been shown to reduce within- and across- method inconsistencies in risk preference elicitation (Reynaud and Couture, 2012).

The objective of this study is to examine the factors that influence farmers' risk management decisions. We consider the possibility of simultaneous utilization of multiple risk reducing instruments and the potential correlations among those adoption decisions. Based on this background, we i) aim to analyze how farm and farmer's characteristics are related to the choice of risk management strategies and ii) aim to reveal which risk attitude parameter elicited from three different risk elicitation methods pertains the farmers' risk behavior best. Our empirical case study focusses on livestock producer in the German Munster region in North-Rhine-Westphalia (Germany). We focus on risk management strategies classified depending on the farmers' choice of resource shift, in three categories: on-farm agriculture, on-farm non-agriculture, and off-farm strategies. The remainder of this paper is structured as follows. Preceded by a literature review, the experimental design is presented. Subsequently, the methodological approach and data are introduced. Finally, the results are presented followed by a discussion and a concluding section.

3.2 Conceptual framework and relevant literature

Economic research in the field of risk behavior and risk management is often based on expected utility theory, with the utility maximizing decision maker at its core (Meyer, 2002). This expected utility hypothesis has been criticized on descriptive grounds, i.e. due to its lack of predictive power of real world decision-making behavior (Kahneman and Tversky, 1979, Slovic, Fischhoff, and Lichtenstein, 1982, Savage, 1972). Thus, we include in our assessment of the farmers' choice of risk management strategy the subjective attitude towards risk and believes regarding the probability of an uncertain outcome occurring (i.e. risk perception). According to subjective expected utility (Savage, 1972, Slovic, Fischhoff, and Lichtenstein, 1982), understanding the individual's reference frame for evaluating choices with uncertain outcomes is crucial. In other words, the farmers' decision-making environment together with his personal characteristics is determining the decision-making behavior. Thus, we introduce a framework recognizing farm, farmer and household characteristics to determine the farmers risk management choice (left hand side in Figure 3.1). The farm holdings' main goal is to allocate its resources, within the economic environment, in a utility maximizing way. According to van der Ploeg and Roep (2003) the farm enterprise has three dimensions where the limited resources (e.g. land, labor and capital) can be allocated: on-farm agricultural, on-farm non-agricultural and off-farm. We propose to adopt these three dimensions of farm resource allocation to the choice of risk management strategies. In our analysis, we focus on risk management strategies related to on-farm agriculture, on-farm non-agriculture, and off-farm decisions (see right hand side Figure 3.1).

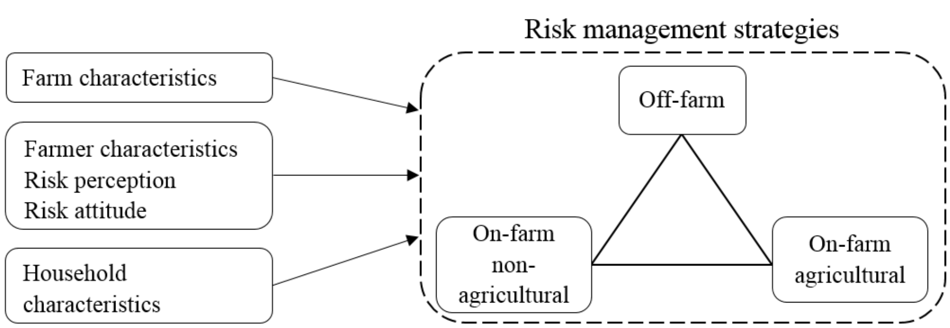


Figure 3.1: Factors influencing farmers' decision-making on farm resource allocation dimensions

Although no study has as yet compared determinants of adoption of those strategies within a single portfolio, in this section we review the literature that addresses determinants of farmers' choices within individual categories. We find empirical evidence that greater risk aversion is associated with a higher uptake probability of off-farm risk management tools. Off-farm risk management strategies can be associated with a reduction of dependency on (risky) farm income. For instance, in a study using Swiss FADN data, de Mey et al. (2016) find that farm households that are exposed to greater financial risks show a higher share of off-farm labor income. Furthermore, van Winsen et al. (2014) find a positive relationship of risk aversion and the uptake of off-farm work and off-farm investments amongst Belgian farmers. Counter intuitively some studies find that insurance uptake is negatively correlated with risk aversion (Menapace, Colson, and Raffaelli, 2015, Hellerstein, Higgins, and Horowitz, 2013, Just, Calvin, and Quiggin, 1999). Some argue that the artificial nature of most risk preference elicitation methods provokes decision-making in experimental settings detached from real world behavior (Menapace, Colson, and Raffaelli, 2015, Hellerstein, Higgins, and Horowitz, 2013). Harrison, List, and Towe (2007) argue that the underlying background risk that farmers are facing leads to those already applying insurance, as a risk management strategy are more willing to take risks in the experiment. Furthermore, the structure of insurance schemes is argued to influence the uptake probability more than risk aversion (Just, Calvin, and Quiggin, 1999). In other research fields, higher risk aversion has been found to go alongside less risk reducing behavior (e.g. Holden and Quiggin, 2016). Risk aversion may hinder or delay the adoption of new technologies, as they are connected to new uncertainty and thus provoke extra caution among more risk averse farmers. Furthermore, the uptake of insurance for irreplaceable commodities (e.g. life at risk) has been shown to decrease with greater risk aversion (Bommier and Le Grand, 2014). Cook and Graham (1977) explain that rational insurance decisions aim at equalizing the marginal utility of wealth across states of nature with irreplaceable commodities this may generate risk taking behavior. Increasing age is expected to decrease off-farm employment opportunities and hence to decrease the share of off-farm risk management tools in the farmers' portfolio (de Mey et al., 2016). Furthermore, saturating effects of age are expected (de Mey et al., 2016), which will be considered in our empirical analysis by including the variable in linear and squared terms. A higher level of education is enhancing the farmers' off-farm labor market opportunities and in turn, increases the likelihood to work outside the farm. As a result, those farmers spend less time on self-protection from risk and rely more on crop insurance. Additionally, farmers with greater risk literacy (subjective numeracy is used as a proxy) are expected to have enhanced ability to acquire and decode information which in turn is associated with higher adoption rates of insurance contracts and participation in the commodity futures exchange (Mishra and El-Osta, 2002, Velandia et al., 2009). Nevertheless, human capital theory suggests that increasing education is associated with decreasing risk aversion and hence less participation in market based risk reducing strategies (Velandia et al., 2009, Shapiro and Brorsen, 1988). This may also hold for participation in agricultural training acquired in workshops –a fact that will be considered in our analysis. Likewise, an optimistic mindset is also assumed to be related to greater willingness to take risks. Thus, optimistic farmers are assumed to have a smaller share of off-farm risk management strategies in their portfolio (Dohmen et al., 2011). Risk perception varies between individuals depending on the objective risk they are exposed to and the subjective interpretation of risks. Risk perception is assumed to be domain specific. Hence, we measure farmers' risk perception in five domains. Results from previous studies suggest that higher risk perception in all domains is associated with higher uptake probability of risk management strategies. So far, the empirical relationship between perceived sources of risks and responses has been ambiguous (Flaten et al., 2005, Meuwissen, Huirne, and Hardaker, 2001, van Winsen et al., 2014). Additionally, Menapace, Colson, and Raffaelli (2013) find that past experienced losses influence the subjective risk perception of farmers. Thus, we assume that farmers that experienced losses over the past five years react with multiple risk management responses. On the farm-household level the availability of more on-farm work force as well as farm succession and greater household size indicate the farm families' need to generate employment on the farm. Farm households with planned succession are according to life cycle theory (succession effect) seeking to create a stable extra income on the farm, consequently they are more likely to generate extra forms of income on the farm to support the new generation of farming family (Potter and Lobley, 1996). Additionally, there is strong evidence that farms with more available workforce on the farm and larger household size are more likely to engage in on-farm non-agricultural diversification strategies (Meraner et al., 2015, Benjamin and Kimhi, 2006).

Larger farm size and greater livestock are both associated with greater wealth and thus a larger capacity to bear risks on the farm, reducing the necessity to shift resources of the farm (Velandia et al., 2009). Larger farms in terms of size and livestock show signs of greater specialization and are thus associated with a greater share of on-farm agriculture related risk management strategies. Moreover, households with a small share of rented land have higher levels of equity, which positively affects their financial stability and in turn reduces the necessity of off-farm risk management tools (de Mey et al., 2016, Mishra and El-Osta, 2002).

3.3 Experimental design

To connect farm, farmer and household characteristics with the farmers risk management decisions, we conducted a survey amongst specialized livestock farmers in the German region North-Rhine-Westphalia in December 2015 and January 2016[19]. Farmers are a popular population subsample for conducting risk experiments, as their profession naturally entails a large degree of risk forcing them to make regularly decisions under risk and uncertainty (Menapace, Colson, and Raffaelli, 2015, Herberich and List, 2012). The survey was distributed via the advisors of the local extension service, to 256 farmers located mainly in the region of Muenster. We included a stamped, self-addressed envelope, leading to a total of 64 responses

[19] The full survey is available in the supplementary files attached.

(representing a 26% response rate). Focusing on a comparable group of farmers with respect to the type of farming, geophysical characteristics of the region and available risk management tools allows us to coherently compare strategies taken by these farmers. We carefully designed the survey based on seven pre-tests including in-depth interviews with young farmers and two expert feedback rounds with farm advisors, ensuring a user-friendly layout and understandability of all questions. The paper pencil questionnaire is structured in the following parts: i) subjective perception of risk, ii) risk preference elicitation, iii) farmer's characteristics, iv) household characteristics, v) information about the farm holding, vi) risk management tools used. Farmers could indicate to get a feedback regarding their risk perceptions, attitudes and management strategies, as well as aggregated information on the whole sample.

In total 51 farmers (80%) of all farmers, participating requested the feedback indicating great interest of farmers in the survey. In line with Menapace, Colson, and Raffaelli (2013) and Reynaud and Couture (2012) this feedback report is used as a non-monetary incentive for the participants.

Risk perception

We use an exploratory approach to measure subjective risk perception where the main sources of risks farmers perceive to be exposed to are not clearly defined. Risk perception can be regarded as the combination of the probability of an uncertain event happening and the incidental impact or negative consequence (Slovic, Fischhoff, and Lichtenstein, 1982). Consequentially, risk perception will increase when the probability of occurrence increases, the magnitude of the impact increases or both increases. To measure the farmers' subjective risk perception we asked farmers to score the perceived probability of 25 different risk sources on a five point scale from 1 (very unlikely) to 5 (very likely) and the perceived impact for each source on a five point scale from 1 (very small impact) to 5 (very big impact). The perceived risk scores are calculated by multiplying the perceived probability of occurrence with the perceived impact (Flaten et al., 2005, Meuwissen, Huirne, and Hardaker, 2001, van Winsen et al., 2014). The 25 risk sources included in in the survey where based on the in-depth expert interviews with two extension service consultants and two farmers as well as a literature study (Meuwissen, Huirne, and Hardaker, 2001, van Winsen et al., 2014, Musser and Patrick, 2002)[20]. For the subsequent analysis, we grouped them according to five main categories of risk sources. Those categories comprise i) market and price risks (e.g. increasing price volatility), ii) political and structural risks (e.g. decreasing direct payments), production risks (e.g. yield volatility due to climate change), financial risks (e.g. liquidity shortage) and other risks (e.g. shortfall of qualified workforce) (Musser and Patrick, 2002). We calculate a risk score for each category by taking the mean overall risk scores in each category.

Risk preferences

To elicit the farmers' risk preferences we include the following three methods in the survey.

Contextualized multiple price list (MPL)

[20] The complete list of all 25 risk sources is included in Table 3.A.1 in Appendix 3.A.

The first measure of risk preferences elicited from the sample of farmers was a contextualized MPL. The MPL is characterized by a fine gradation in the risky choices and uses real rather than hypothetical outcomes. Following Holt and Laury (2002) we assume constant relative risk aversion (CRRA)[21]. The CRRA utility is defined as $U(x) = (1-r)^{-1}x^{1-r}$, where r is the CRRA coefficient. In the following analysis, we use the CRRA interval mid-point as the farmer's risk preference parameter (see column 7 in Table 3.1). We create a realistic payout structure of the contextualized MPL using payouts ranging from 5€ to 192.5€. The upscaling of payouts does not change the original CRRA intervals used by Holt and Laury (2002) but creates an incentive compatible MPL[22]. A risk-neutral person would select option A in the first four rows of Table 3.1 and option B in the last six rows. Nevertheless, the main challenges with this risk preference elicitation is its relative complexity leading to inconsistent choices and reduced predictive power (Charness, Gneezy, and Imas, 2013). Based on findings of Harrison, List, and Towe (2007), Menapace, Colson, and Raffaelli (2015), and Hellerstein, Higgins, and Horowitz (2013) we use a modified wording of the standard lottery to reduce complexity. More specifically, we use a wording explicitly framed in an agricultural context to create decision-taking approaches closer to those that farmers have previously experienced[23]. To this end, we

[21] The assumption of constant relative risk aversion (CRRA) has been shown to hold in the context of medium-scale lottery in developed countries (Heinemann, 2008).

[22] The expected return for each participating farmer is 9.50 €, the average time to complete the questionnaire was estimated at 20 minutes, resulting in an hourly wage equivalent of 28.50 €.

[23] The MPL question reads as following: "Assume that you are offered to make an agricultural investment. Here you will get with different associated probabilities for investment A a return of 100,000 € or 80,000 € and for investment B a return of 192,500 € or 5,000 €. You can choose in the following table in each row between the two investment options (A or B)."

multiplied returns in the contextualized MPL by a thousand tokens. Participants were instructed that real payouts are reconverted by the factor of one thousand. Furthermore we reduce complexity and consequential inconsistent behavior by including a pie chart displaying proportions next to the verbal presentation of decisions as a visual aid (Bougherara, Gassmann, and Piet, 2011, Reynaud and Couture, 2012) (an example of the visual presentation as well as full instructions are found in Figure 3.A.1 in Appendix 3.A). To incentivize the MPL we follow Maart-Noelck and Musshoff (2014) and informed farmers that at the end of the survey period 10% of all participants are selected for real payouts based on their choices[24].

Table 3.1: Standard payoff table MPL

Choice Nr.	Prob. 1 vs. Prob. 2	Option A	Option B	Difference in expected payouts a)	Open CRRA interval a) b)	CRRA interval mid-point a)
1	10% vs. 90%	100€ vs. 80€	192.5€ vs. 5€	58.25	r < -1.71	-1.71
2	20% vs. 80%	100€ vs. 80€	192.5€ vs. 5€	41.50	-1.71 < r ≤ -0.95	-1.33
3	30% vs. 70%	100€ vs. 80€	192.5€ vs. 5€	24.75	-0.96 < r ≤ -0.49	-0.72
4	40% vs. 60%	100€ vs. 80€	192.5€ vs. 5€	8.00	-0.50 < r ≤ -0.14	-0.31
5	50% vs. 50%	100€ vs. 80€	192.5€ vs. 5€	-8.75	-0.15 < r ≤ 0.15	0.00
6	60% vs. 40%	100€ vs. 80€	192.5€ vs. 5€	-25.50	0.16 < r ≤ 0.41	0.28
7	70% vs. 30%	100€ vs. 80€	192.5€ vs. 5€	-42.25	0.42 < r ≤ 0.68	0.54
8	80% vs. 20%	100€ vs. 80€	192.5€ vs 5€	-59.00	0.69 < r ≤ 0.97	0.82
9	90% vs. 10%	100€ vs. 80€	192.5€ vs. 5€	-75.75	0.98 < r ≤ 1.37	1.17
10	100% vs. 0%	100€ vs. 80€	192.5€ vs. 5€	-92.50	1.37 < r	

Source: Own depiction according to Holt and Laury (2002) and Harrison, Lau, and Rutström (2007). Note: all currency units are in EURO at the time of the experiment 1 USD = 0.92 EURO. Note that the returns have been scaled up by a thousand tokens. a) Not shown to participants; b) Assuming a power utility function $U(x) = (1-r)^{-1}x^{1-r}$.

Self-assessment (SA) of risk preferences

Second, we included the following straightforward SA of the willingness to take risk: ‘On a scale from 0 to 10, where 0 means “not at all willing to take risks” and 10 means

[24] This between-subjects random incentive system reduces the probability for real payout for every task; however it allows to award higher prices to the participants and reduces the high administrative costs related to paying each participant in a mail survey.

“very willing to take risks”, how would you assess your personal preference to take risks?’ (following Dohmen et al., 2011). To ensure consistency with the results of the other risk preference elicitation methods included in this study the self-assessment values are inverted so that higher values imply higher risk aversion. This instrument’s biggest advantage is its simplicity, resulting in a wide potential for collecting risk preference measurements at a very low marginal cost (Menapace, Colson, and Raffaelli, 2015). Dohmen et al. (2011) show that for some domains risk preferences elicited in the SA and lottery task are highly correlated. Moreover, Maart-Noelck and Musshoff (2014) find significant correlations of estimated risk attitudes in both tasks (SA and MPL) in a sample of German farmers. However, as the question is not contextualized to a specific risk domain the applicability to predict real farm-level risk management behavior might be limited (Menapace, Colson, and Raffaelli, 2015).

Business statements (BS)

Third, we use the following four BS related to three major sources farmers are exposed to and to agriculture in general: “On a scale from 1 to 5, where 1 means “fully agree” and 5 means “don't t agree” please indicate your position on the following statements: “I am willing to take more risks than my colleagues with respect to 1. … production risks; 2. … marketing and pricing risks; 3. … financial risks; 4. … farming in general.” These contextualized questions follow other studies (e.g. Meuwissen, Huirne, and Hardaker, 2001, Flaten et al., 2005, van Winsen et al., 2014, Bishu et al., 2016) ensuring comparability of results. This method is simple, fast to complete and allows for domain specific contextualization, i.e. directly referring to the main sources of risk in agricultural practice. Since those statements measure attitude towards risks relative to other farmers following Meuwissen, Huirne, and Hardaker (2001) we use the term 'relative risk attitude' in the remainder of this paper[25].

Socio economic characteristics

Our survey also included questions on farmers' personal characteristics that comprise the farmers' age, level of education, participation in agricultural training sessions and experienced past losses. Additionally, to capture the general level of optimism we included two questions addressing the farmers' current life satisfaction and predicted life satisfaction in one year. We used a set of seven self-assessment questions on numerical aptitude and preferences for numbers, adapted from Fagerlin et al. (2007) to measure the farmers' subjective numeracy and ability to process probabilistic information. This subjective numeracy test is faster, avoids frustration amongst participants and correlates strongly with risk comprehension and objective numeracy tests (i.e. mathematical tasks) (Fagerlin et al., 2007, Zikmund-Fisher et al., 2007). On the household level, we included information on the farms' work force availability, farm succession and household size. The collected farm-holding information includes the farm size (agricultural area), the proportion of rented land, and size of livestock.

Risk management strategies

Finally, the survey included a list of 16 risk management tools (see Appendix 3.A Table 3.A.2). The list was developed following earlier research focusing on similar farm types and/or similar production regions (e.g. Meuwissen, Huirne, and Hardaker,

[25] However, the scale does not allow for a quantitative interpretation in terms of a risk aversion coefficient.

2001, Schaper, Bronsema, and Theuvsen, 2012, Musser and Patrick, 2002) as well as in-depth expert interviews with extension service consultants and farmers. These interviews also clearly revealed that it is not a single risk management strategy which is relevant for our case study. In contrast, a combination of strategies is usually applied. Consequentially, we included a list of 16 different risk management strategies in the survey, asking farmers to choose those strategies applied on their farm. For the subsequent analysis, we classify the 16 risk management strategies according to three different areas where the farmer may shift her/his resources to (following van der Ploeg and Roep, 2003). First, resources are kept on the farm holding, focusing on agricultural production, second, the resources are shifted towards risk management efforts on the farm not primarily related to agricultural production. Third, resources are shifted away from the farm holding to a third party. In the remainder of this paper, the first category will be referred to as "on-farm agricultural" and includes the following risk management strategies: investment in new technologies (e.g. irrigation), agricultural diversification, risk adapted production and use of robust or resistant varieties and breeds. The second category named "on-farm non-agricultural" includes: non-agricultural diversification, work harder or cut private expenses, cooperation with other farmers and building reserves. Finally, the third category labeled "off-farm" risk management strategies includes: working off the farm, yield insurance, hail insurance, multiple risk insurance, business liability insurance + floor-coverage + environmental liability, legal protection insurance, trading on the commodity futures exchange, and off-farm investment. For the further analysis, we categorize the farmers' choices of risk management. As all farmers use a portfolio of different risk management tools, we categorize them by maximizing the mean over all choices in each risk management category (i.e. they are categorized depending on the largest share of risk management tools applied).

3.4 Methodology

To identify the determinants of risk management behavior we estimate a multinomial probit model (Verbeek, 2008). This choice (e.g. in favor of a multinomial logit model) is motivated by the fact the unobserved error terms of the separate probit models are very likely not independent[26]. Ignoring this correlation in analyzing the simultaneous adoption of risk management tools may lead to biased estimates of the choice probabilities and incorrect estimates of the standard errors of the parameters (Verbeek, 2008). We estimate the observed choices as a function of risk preferences, perceptions and socio- economic farm, farmer and household characteristics (a detailed description of all variables is found in Table 3.2). We simultaneously estimate the farmers' preferred risk management category: on-farm agriculture (j=1), on-farm non-agriculture (j=2) and off-farm and mixed strategies[27] (j=0). In other words, we assume the farmer to prefer one of the three categories depending on the averagely highest amount of risk management tools chosen in each category (j=1 if the farmer choses on

[26] When testing the multinomial logit model for our data, the seemingly unrelated estimation test indicates a violation of the assumption of independent alternatives (Weesie, 1999). The results of the estimation using the multinomial logit models can be found in Appendix 3.A Table 3.A.5.

[27] Seventeen farmers use a mix of strategies with no clear favored category; they are grouped in the off-farm category as the preferred mix always includes off-farm strategies.

average mainly on-farm agriculture related strategies; j=2 if the farmer choses on average mainly on-farm non- agriculture related strategies and j=0 if the farmer choses on average mainly off-farm strategies to manage her/his risks). Specifically, we estimate the probability that one of the risk management classes is preferred (i.e. is chosen more frequently) over the other classes:

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

$$\text{with } y_i = \begin{cases} 1 \text{ if } y_{i\,on\,farm\,agriculture}^{*} > 0 \\ 2 \text{ if } y_{i\,on\,farm\,non-agriculture}^{*} > 0 \\ 0 \text{ otherwise.} \end{cases}$$

$$x_j = \text{vector of observable farm, farmer and household characteristics}$$

Where β_{ij} is a vector of parameters specific to the j-th alternative associated with the vector x_j, which contains the observable farm, farmer and household characteristics. The error terms ε_{ij} are assumed to be multivariate normally distributed with mean zero. The category off-farm risk management is chosen as base category.

The estimation is repeated for each of the six risk preference elicitation methods included plus the average over four business statements (MPL, SA, BS production, BS market and prices, BS financial, BS agriculture generally, BS average) in order to test which risk preference elicitation method relates best to the farmers' risk management choice using the statistical software STATA13.1.

In addition, we assess the cross-method consistency of risk preference elicitation methods in our analysis, by testing whether risk preferences elicited with individual approaches point in the same direction. To account for the ordinal nature of risk preferences, tests on rank correlations are used.

3.5 Data

In Table 3.2 we present a description of all variables included in the further analysis. Table 3.3 provides summary statistics for all variables used. We include only observations with no missing values in order to have a consistent data set throughout the different estimations[28]. Consequently, the data set reduces to 56 farmers. We find only two missing values for the MPL and one for the SA task, thus there is great evidence that the instructions of the MPL, combined with the visual aid decreased complexity. Furthermore, the inconsistency rate in the MPL is low (10% of farmers switch multiple times in the MPL). Following Holt and Laury (2002), and Abdellaoui, Driouchi, and L'Haridon (2011), we argue that the bias regarding the average number of safe choices is negligible, calculating the corresponding CRRA interval mid-point based on the individual's first transition to the riskier choice B. On average across all surveyed farms, the main farm operator are 45 years old, cultivate about 107 ha of land of which 50% are rented. Typically for the area most farms are livestock oriented (pig or cattle), with an average of 951 pigs or piglets and 73 cattle[29]. The regional average for agricultural area and livestock is around 20% lower; this is very likely because we have an overrepresentation of full time farmers in our survey (none of the participants earning more than 50% of their income outside agriculture). We find that the sample

[28] Note that this listwise deletion of missing values ensures comparability of the models. Furthermore, we do not find estimation biases, i.e. can assume that missing values are random.

[29] The full data set and estimation code are available in the supplemental file attached.

contains highly educated[30] and slightly optimistic farmers, who self-assess their numeracy to be good. They attend on average two agricultural training workshops per year. Farmers in our sample perceive market and price risks most severely, followed by political and structural risks. This is in line with findings amongst Dutch livestock farmers by Meuwissen, Huirne, and Hardaker (2001) as well as results gained in a study by Flaten et al. (2005) for Norwegian dairy farmers. Most of the farmers (80%) claim to have experienced major losses over the past five years. Furthermore, most farm businesses are operated with 2.5 labor units and on average five people live in the farm household. The farm succession is for most farmers planned and quite certain.

[30] The mode degree of education in the sample is at the level of state certified agriculturalist (implying a minimum of 13 years of schooling).

Table 3.2: Variable description

Variable	Variable definition
Farmer characteristics	
Risk preferences	
MPL	CRRA interval mid-point
SA	General risk preferences on inverse scale from 0 (= very unwilling to take risks) to 10 (= very willing to take risks)
	Willingness to take more risks than my colleagues with respect to…
BSProd	production, on scale from 1 = agree, 5 = don't agree
BSMark	marketing and prices production, on scale from 1 = agree, 5 = don't agree
BSFin	financial issues, on scale from 1 = agree, 5 = don't agree
BSAg	farming in general, on scale from 1 = agree, 5 = don't agree
Ø BS	Average of four BS
Age	Years
Educ	Highest degree of education according to the German schooling system (0-10)
Optim	Life satisfaction in one year (on a scale from 1 = “not satisfied” to 10 = “very satisfied”) - life satisfaction now (on a scale from 1 = “not satisfied” to 10 = “very satisfied”)
SN	Mean subjective numeracy score (1 = very good numeracy; 6 = very bad numeracy)
AgricTrain	Attendance of agricultural training workshops per year (0 = none; 1 = one; 2 = two to three; 4 = four to five; 4 = more than five)
Risk perception	Perceived probability of occurrence (1 = “not likely”, 5 = “very likely”) multiplied by perceived impact on 1 to 5 scale (1 = “no impact”, 5 = “very strong impact”) in four domains
PerMarkRisk	Perceived market risks
PerPolRisks	Perceived political risks
PerProdRisk	Perceived production risks
PerFinRisk	Perceived financial risks
PerOtherRisk	Perceived other risks
ExpLosses	1 if experienced severe losses over the past five years
Household characteristics	
WF	Number of full time workforce available
FarmSuc	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
HHS	Household members living in the farm household
Farm characteristics	
AgricArea	Agricultural area in ha
PropRentLand	% of rented land that is cultivated
LivePig	Number of pigs or piglets
LiveCattle	Number of cattle

Table 3.3: Summary statistics of complete surveys N = 56

	All farmers N = 56			Off-farm N = 21			On-farm agric N = 16			On-farm non-agric N = 19		
Variable	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**
Farmer characteristics												
MPL	0.30	0.66	0.54	0.28	0.68	0.54	0.44	0.50	0.54	0.20	0.78	0.28
SA	5.45	2.19	6.00	5.38	2.25	6.00	5.44	2.45	6.50	5.53	2.01	6.00
BSProd	3.02	1.10	3.00	3.05	1.16	3.00	2.81	1.11	2.50	3.16	1.07	3.00
BSMark	3.125	1.03	3.00	3.10	1.18	3.00	2.94	1.00	3.00	3.32	0.89	3.00
BSFin	3.18	1.21	3.00	2.95	1.28	3.00	3.56	1.12	4.00	3.11	1.15	3.00
BSAg	3.02	1.07	3.00	3.05	1.20	3.00	2.75	1.07	2.50	3.21	0.92	3.00
BSProd	3.09	0.94	3.00	3.04	1.09	3.00	3.02	0.88	2.88	3.20	0.85	3.00
Ø BS	3.02	1.10	3.00	3.05	1.16	3.00	2.81	1.11	2.50	3.16	1.07	3.00
Age	45.29	11.16	47.00	44.67	11.49	47.00	46.38	12.71	47.50	45.05	9.88	47.00
Educ	8.32	1.39	8.00	8.48	0.87	8.00	8.38	1.63	8.00	8.11	1.66	8.00
Optim	0.18	0.74	0.00	0.24	0.70	0.00	0.13	0.50	0.00	0.16	0.96	0.00
SN	2.06	0.60	2.07	1.87	0.74	1.71	2.32	0.43	2.29	2.05	0.50	2.14
AgricTrain	2.79	1.09	3.00	2.95	0.97	3.00	2.69	0.95	2.50	2.68	1.34	3.00
PerMarkRisk	13.53	3.85	13.80	14.23	3.11	13.80	12.47	4.58	12.95	13.66	3.93	14.00
PerPolRisks	12.42	3.49	12.69	12.44	3.58	11.50	12.25	3.24	13.13	12.53	3.78	12.63
PerProdRisk	10.51	3.04	10.20	10.53	9.82	10.20	10.32	2.92	10.30	10.65	3.19	10.20
PerFinRisk	9.62	4.18	9.50	9.74	4.36	9.00	8.69	4.71	7.00	10.26	3.54	10.50
PerOtherRisk	9.86	2.74	9.60	9.55	2.44	9.60	10.38	3.09	10.30	9.77	2.84	9.40
ExpLosses	0.82	0.39	1.00	0.71	0.46	1.00	0.94	0.25	1.00	0.84	0.37	1.00
Household characteristics												
WF	2.52	1.23	2.25	2.58	1.30	3.00	2.39	1.01	2.25	2.56	1.37	2.00
FarmSuc	0.55	0.53	0.50	0.50	0.55	0.50	0.47	0.59	0.50	0.66	0.44	1.00
HHS	4.98	1.69	5.00	4.95	1.75	5.00	4.94	2.02	6	5.05	1.39	5.00
Farm characteristics												
AgricArea	106.97	91.79	89.00	101.79	54.58	90.00	90.84	47.96	83.50	126.28	140.92	87.00
PropRentLand	0.29	0.50	0.52	0.59	0.30	0.67	0.46	0.26	0.50	0.41	0.27	0.46
LivePig	950.64	1159.68	378.50	691.38	1024.57	0.00	702.31	1154.94	0.00	1446.32	1199.48	1700.00
LiveCattle	72.73	117.34	0.00	93.51	101.48	100.00	61.56	88.16	0.00	59.11	152.77	0.00

3.6 Results

All risk aversion coefficients elicited using different risk preference elicitation methods show that farmers in our sample are – on average – risk averse. However, there is heterogeneity with respect to risk preferences within the overall sample. The average CRRA interval mid-point is 0.30 (Table 3.2), which corresponds to values elicited by Maart-Noelck and Musshoff (2013) for German farmers. However, in the self-assessment of risk preferences are farmers in our sample on average more risk averse (5.45) than German farmer in the sample of Maart-Noelck and Musshoff (2013) (4.9). Based on the four business statements, we find most farmers to identify a relative risk neutral position in all four relevant domains (mode = 3.00), which is in line with results of Meuwissen, Huirne, and Hardaker (2001) in a sample of Dutch livestock farms. The illustrated differences in means is additionally tested significantly using Hottelings T-squared test. Additionally, Appendix 3.A Figure 3.A.2 shows the Kernel density plots of CRRA estimates, self-assessment and average business statements in the sample, as well as risk neutrality (dotted line).

To analyze how risk attitude parameters elicited using different risk preference elicitation methods pertain farmers' risk management decisions, we first examine farmers' risk preference consistency across the three methods. Table 3.4 shows the Spearman correlation coefficient of risk preferences elicited through the three different methods[31] (generating seven parameters of risk aversion). We find a significantly

[31] Additionally Pearson correlation coefficients are found in the Appendix 3.A Table 3.A.3.

positive correlation of all preference estimations. Thus, all risk preference elicitation methods reveal a consistent representation of the farmers' risk preferences (i.e. if risk averse in one task most farmers also behave risk averse in the other tasks).

Table 3.4: Spearman correlation coefficients of risk preferences elicited with different methods

N=61[32]	MPL	SA	Ø BS	BSProd	BSMark	BSFin	BSAg
MPL	1.000						
SA	0.714***	1.000					
Ø BS	0.417***	0.661***	1.000				
BSProd	0.492***	0.675***	0.844***	1.000			
BSMark	0.357***	0.491***	0.804***	0.677***	1.000		
BSFin	0.264**	0.521***	0.753***	0.492***	0.428***	1.000	
BSAg	0.349***	0.586***	0.905***	0.740***	0.701***	0.602***	1.000

** Significant at the 5% level, *** significant at the 1% level

Additionally, we checked for multicollinearity for the variables used to test for risk attitude and risk perception. Contrarily to suggestions by some researchers (Menapace, Colson, and Raffaelli, 2013, van Winsen et al., 2014), we do not find a significant correlation of risk attitude and risk perception in our sample.

Table 3.5 and Table 3.6 summarize the estimated coefficients and standard errors for seven multinomial probit models estimated. The independent variables, which are described in Table 3.2, are equivalent across the seven models except for the specification of the risk aversion variable, which varies in each model. More specifically we estimate separate models for each risk preference elicitation method:

[32] Note that we excluded three non-responding farmers for this analysis.

MPL, SA, BS production, BS marketing and prices, BS finances, BS agriculture generally and the average over all business statements. We find 21 of the participants have on average mostly off-farm risk management strategies, 16 choose on average mainly on-farm agriculture related risk management tools and 19 engage mainly in on-farm non-agriculture related risk management strategies. For all multinomial probit models the hypothesis of identical probabilities for each category can be rejected (Table 3.5 and Table 3.6).

We find that greater risk aversion increases the probability that farmer's focus on on-farm strategies (compared to choosing off-farm strategies). More specifically, when risk preferences are measured via the self-assessment (SA), business statement (BS) on production risks, marketing and price risks, and agricultural risks in general, a positive impact of risk aversion on on-farm non-agriculture strategies is found. However, for risk preferences elicited using the contextualized MPL and in the business statement on financial risks the probability to mainly rely on on-farm agriculture related risk management tools increases.

Furthermore, our results show that with increasing age farmers are more likely to engage in on-farm non-agriculture related risk management tools compared to off-farm strategies. In contrast, older farmers are less likely choose on-farm agriculture related risk management strategies in two out of our seven models. Education has a positive effect on the probability of a larger share of on-farm agriculture related risk management tools compared to off-farm strategies. Risk literacy has a significant effect on the probability of farmers to focus on on-farm risk management. More specifically, with increasing risk literacy the probability of farmers to engage in more on-farm risk management strategies decreases. In contrast, more risk literate farmers are more likely to use off-farm measures. A high perception of market risks decreases the probability of farmers to focus on on-farm agricultural risk management strategies compared to off-farm strategies. A higher perception of other risks (i.e. workforce, societal acceptance) increases the probability of farmers focusing on on-farm agriculture related risk management strategies in five out of seven of the estimated models. Furthermore, larger farms are more likely to engage in off-farm risk management strategies. We find an increasing share of rented land is associated with a higher probability of farmers focusing on off-farm risk management tools than on-farm non-agriculture related tools. Farmers that experienced losses in any of the five domains show an increased probability to focus on on-farm risk management tools in their risk management portfolio. If the farm succession is sure the probability to engage in on-farm not agriculture related risk management strategies increases.

Table 3.5: Multinomial probit estimates for MPL, SA and average BS

	MPL		SA		Ø BS	
N = 56	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture
Farmer characteristics						
Risk aversion	1.870**	0.229	-0.047	0.328*	0.916	1.274**
	(0.811)	(0.542)	(0.227)	(0.201)	(0.630)	(0.570)
Age	-1.124**	0.602*	-1.020**	0.661*	-1.163**	0.241
	(0.552)	(0.330)	(0.468)	(0.367)	(0.511)	(0.358)
Age^2	0.014**	-0.006*	0.012**	-0.007*	0.014**	-0.003
	(0.006)	(0.004)	(0.005)	(0.004)	(0.006)	(0.004)
Educ	0.531	-0.300	0.982**	-0.337	0.856**	-0.544
	(0.338)	(0.287)	(0.457)	(0.340)	(0.393)	(0.379)
Optim	-0.268	-0.394	-0.099	-0.260	0.342	0.067
	(0.499)	(0.444)	(0.511)	(0.450)	(0.486)	(0.411)
SN	3.578***	1.424*	3.409***	1.264**	3.447***	1.274**
	(1.158)	(0.645)	(1.023)	(0.649)	(0.988)	(0.551)
AgricTrain	-0.125	0.323	-0.243	0.002	-0.432	0.143
	(0.365)	(0.326)	(0.427)	(0.361)	(0.407)	(0.311)
PerMarkRisk	-1.067***	-0.211	-1.049***	-0.306*	-1.148***	-0.339**
	(0.326)	(0.139)	(0.310)	(0.157)	(0.337)	(0.158)
PerPolRisks	0.131	0.119	0.243	0.100	0.194	0.109
	(0.186)	(0.136)	(0.183)	(0.147)	(0.179)	(0.142)
PerProdRisk	-0.126	-0.068	-0.089	-0.092	-0.117	-0.067
	(0.186)	(0.134)	(0.147)	(0.134)	(0.147)	(0.136)
PerFinRisk	-0.151	0.041	-0.261*	0.106	-0.169	0.126
	(0.115)	(0.093)	(0.137)	(0.100)	(0.141)	(0.116)
PerOtherRisk	0.400**	0.030	0.363*	0.035	0.426*	0.035
	(0.220)	(0.171)	(0.220)	(0.165)	(0.221)	(0.165)
ExpLosses	10.537***	2.524**	9.968***	2.391***	9.877***	2.577***
	(2.683)	(0.957)	(2.294)	(0.896)	(2.195)	(0.943)
Household characteristics						
WF	-0.020	-0.015	-0.015	0.042	0.176	0.375
	(0.435)	(0.463)	(0.463)	(0.366)	(0.440)	(0.341)
FarmSuc	-0.750	2.172**	-1.311	2.363**	-0.945	2.159***
	(1.260)	(0.962)	(1.396)	(0.977)	(1.117)	(0.813)
HHS	-0.485	0.136	-0.357	0.089	-0.354	0.123
	(0.340)	(0.232)	(0.287)	(0.244)	(0.316)	(0.247)
Farm characteristics						
AgricArea	-0.022*	0.003	-0.020	0.003	-0.024*	0.001
	(0.012)	(0.004)	(0.013)	(0.004)	(0.012)	(0.004)
PropRentLand	1.530	-5.549***	1.471	-4.955***	1.107	-5.915***
	(2.339)	(1.664)	(2.386)	(1.500)	(2.505)	(1.746)
LivePig	0.001	0.000	0.000	0.001**	0.001	0.001***
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
LiveCattle	0.011*	0.001	0.008**	0.003	0.010**	0.005
	(0.005)	(0.004)	(0.004)	(0.003)	(0.005)	(0.003)
Constant	13.758	-15.693*	8.127	-12.190	10.227	-8.804
	(11.152)	(8.232)	(9.282)	(8.668)	(9.535)	(8.519)
Wald Chi2(40)		95.40		90.08		97.48
Log pseudolikelihood		-33.728		-34.160		-33.963
Prob > chi2 =		0.000		0.000		0.000

* Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

Table 3.6: Multinomial probit estimates for BS production, BS marketing and prices, BS finances and BS agriculture generally

	BSProd		**BSMark**		**BSFin**		**BSAg**	
N = 56	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture
Farmer characteristics								
Risk aversion	0.519	0.546**	0.449	1.018**	1.118**	0.556	-0.489	0.718*
	(0.525)	(0.370)	(0.502)	(0.440)	(0.445)	(0.408)	(0.535)	(0.410)
Age	-1.067**	0.430	-1.026**	0.282	-1.331***	0.375	-1.200**	0.259
	(0.518)	(0.308)	(0.460)	(0.314)	(0.466)	(0.388)	(0.533)	(0.379)
Age^2	0.013**	-0.005	0.013**	-0.003	0.016***	-0.004	0.015**	-0.003
	(0.006)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.006)	(0.004)
Educ	0.991**	-0.279	0.852**	-0.511	0.802*	-0.379	1.156***	-0.342
	(0.414)	(0.282)	(0.390)	(0.342)	(0.434)	(0.368)	(0.407)	(0.297)
Optim	0.169	-0.233	0.166	-0.081	0.891*	0.037	-0.124	-0.174
	(0.447)	(0.413)	(0.497)	(0.408)	(0.474)	(0.520)	(0.703)	(0.415)
SN	3.143***	1.211**	3.411***	1.510***	3.230***	1.365**	3.923***	1.115**
	(1.019)	(0.559)	(0.955)	(0.543)	(0.997)	(0.607)	(1.030)	(0.502)
AgricTrain	-0.403	0.187	-0.446	-0.026	-0.677*	0.152	-0.052	0.221
	(0.407)	(0.309)	(0.407)	(0.313)	(0.389)	(0.319)	(0.423)	(0.285)
PerMarkRisk	-1.017***	-0.234	-1.085***	-0.299*	-1.192***	-0.344**	-1.104***	-0.181
	(0.302)	(0.131)	(0.336)	(0.159)	(0.276)	(0.160)	(0.310)	(0.136)
PerPolRisks	0.153	0.083	0.204	0.099	0.274	0.204	0.286	0.078
	(0.171)	(0.142)	(0.183)	(0.143)	(0.168)	(0.139)	(0.185)	(0.136)
PerProdRisk	-0.102	-0.050	-0.055	-0.006	-0.162	-0.092	-0.076	-0.035
	(0.143)	(0.128)	(0.147)	(0.142)	(0.143)	(0.139)	(0.149)	(0.138)
PerFinRisk	-0.216	0.057	-0.222	0.058	-0.100	0.114	-0.275*	0.054
	(0.136)	(0.094)	(0.139)	(0.095)	(0.145)	(0.122)	(0.144)	(0.085)
PerOtherRisk	0.444**	0.060	0.391*	0.026	0.333	-0.062	0.291	-0.044
	(0.224)	(0.154)	(0.220)	(0.166)	(0.208)	(0.176)	(0.244)	(0.162)
ExpLosses	9.451***	2.257***	9.837***	2.454***	9.472***	2.344**	11.146***	2.434***
	(2.136)	(0.869)	(2.169)	(0.927)	(2.100)	(0.904)	(2.356)	(0.911)
Household characteristics								
WF	-0.014	0.236	0.119	0.360	-0.168	0.272	-0.123	0.211
	(0.429)	(0.360)	(0.490)	(0.347)	(0.422)	(0.367)	(0.542)	(0.350)
FarmSuc	-0.895	2.183**	-1.013	1.913**	-0.625	2.055**	-1.835	1.780**
	(1.169)	(0.900)	(1.204)	(0.830)	(1.069)	(0.929)	(1.203)	(0.817)
HHS	-0.317	0.120	-0.403	0.059	-0.387	0.122	-0.333	0.106
	(0.311)	(0.238)	(0.309)	(0.229)	(0.312)	(0.266)	(0.305)	(0.258)
Farm characteristics								
AgricArea	-0.021	0.001	-0.021*	0.001	-0.019	0.003	-0.020	0.002
	(0.014)	(0.004)	(0.012)	(0.004)	(0.012)	(0.004)	(0.012)	(0.004)
PropRentLand	1.934	-4.709***	1.163	-5.603***	1.368	-5.559***	1.155	-5.273***
	(2.620)	(1.449)	(2.490)	(1.628)	(2.413)	(1.654)	(2.449)	(1.566)
LivePig	0.001	0.001**	0.001	0.001***	0.001	0.001**	0.000	0.001**
	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)
LiveCattle	0.010*	0.003	0.009**	0.005	0.013***	0.003	0.008	0.004
	(0.005)	(0.003)	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)
Constant	7.924	-13.183*	8.573	-9.132	15.727*	-9.788	10.602	-8.911
	(8.896)	(7.630)	(9.335)	(7.984)	(9.123)	(9.578)	(10.712)	(8.247)
Wald Chi2(40)		128.59		108.23		124.31		110.47
Log pseudolikelihood		-35.046		-33.783		-33.557		-33.441
Prob > chi2 =		0.000		0.000		0.000		0.000

* Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

3.7 Discussion

Risk preferences derived from three different elicitation methods used in our analysis are all highly correlated. Thus, our analysis shows that high between method consistency can be obtained by using a contextualization of the MPL combined with a visual aid. Consequentially, our findings point towards possible improvements to earlier studies on farmers' risk preferences that reveal high between method inconsistencies for non-contextualized MPL settings (e.g. Reynaud and Couture, 2012, Anderson and Mellor, 2009, Menapace, Colson, and Raffaelli, 2015).

In addition, our results show that risk averse farmers are more likely to prefer a larger share of on-farm risk management tools (compared to off-farm strategies). This confirms Flaten et al. (2005), Hellerstein, Higgins, and Horowitz (2013), and Menapace, Colson, and Raffaelli (2015) who find that risk averse farmers are less likely to apply market based risk management strategies such as crop insurance. Hellerstein, Higgins, and Horowitz (2013) argue similar to Herberich and List (2012) that this counter intuitive result stems from the background risk influencing the farmers' decision in an experimental setting, and call for a richer structural model of farming practices and experimental choices. By contextualizing the MPL and including a large portfolio of risk management strategies, we attempt to eliminate some of the background risk. Our results show that for some off-farm strategies included in our studies (e.g. trading on the commodity futures exchange) the argument made by Holden and Quiggin (2016) that greater risk aversion is associated with lower adoption rates of new technologies due to the uncertainty associated with the new risk management strategy. Moreover, farming is usually associated with a high degree of identification of farmers with their profession and farm holding. Thus, many farmer may evaluate their yield and farming business as irreplaceable in the sense that there are no equivalent commodities available on the market (Cook and Graham, 1977). For a risk averse farmer this may imply risk-taking behavior that is reduced by risk aversion (resulting in on-farm risk management strategies) and a reduced demand of insurance.

Furthermore, our results show domain dependence of risk preferences (Dohmen et al., 2011). Farmers showing risk averse preference in the financial domain (MPL and financial business statement) are more likely to focus on on-farm agricultural risk management strategies, we can hypothesis that they have less trust in financial markets and thus focus on on-farm solutions. Farmers who are less willing to take risks with respect to agricultural production, marketing and pricing and agriculture in general than their colleagues are more likely to focus on on-farm non-agricultural risk management strategies, i.e. keeping their resources on the farm but away from agricultural production.

Furthermore, our findings show that off-farm risk management is preferred by middle aged farmers (between 40 and 50), whereas younger farmers prefer on-farm agriculture related risk management tools and older farmers prefer on-farm non-agriculture related risk management tools. This result confirms findings by van Winsen et al. (2014) and Flaten et al. (2005), who find that older farmers are less likely to apply off-farm risk management strategies. Consistent with Potter and Lobley (1996) who describe the farm family development cycle as periods of excess and undersupply of resources our results show that younger farmers can be assumed to have excess labor capacities and lack of financial resources, thus agricultural production related on-farm risk management tools are dominant in their risk management portfolio. With increasing age, farmers' focus of risk management strategies shifts towards off-farm tools. This effect however saturates and in the final stage of the professional career, on-farm non-agriculture related risk management tools are preferred. Older farmers are concerned with building up a future for the next generation on the farm and thus shift the excess resources towards new on-farm ventures or building reserves. More general, our results show that building up long-term ties for the future generation plays a significant role in the choice of risk management tools. Our findings show that farm households with anticipation of succession are more likely to focus on on-farm non-agriculture related risk management tools. Potter and Lobley (1996) explain that farm households with successors focus on setting up capital to provide a living for the successor. Thus, depending on the stage of the succession process these farms are more likely to focus their risk management strategies on building reserves, working harder, cooperating with other farmers and investing in on-farm non-agricultural diversification ventures.

Farmers that have a higher subjective numeracy score are more likely to use more off-farm risk management tools. As subjective numeracy has been shown to correlate positively with risk comprehension (Zikmund-Fisher et al., 2007), this results shows that farmers with a better understanding of probabilities and preferences for numbers are more likely to take on more insurances, trade on the commodity futures exchange, or engage in off-farm work and investments i.e. activities that require high numeracy skills. Moreover, we find that risk perception is directly influencing the decision of risk management strategies applied. Thus, we can confirm findings by Meuwissen, Huirne, and Hardaker (2001) and Flaten et al. (2005) who find a significant influence of risk perception on farmers risk behavior. More specifically, a high perception of market risks as well as other risks increase the probability of farmers to focus on off-farm risk management strategies. Our results show that with increasing farm size, the likelihood to apply on-farm risk management strategies related to agricultural production decreases. Farmers that experienced major losses in the past 5 years are more likely to engage in on-farm (both agricultural and non-agricultural) risk management strategies, compared to off-farm risk management tools. This result is counter intuitive as experienced past losses are assumed to increase risk perception and in turn the probability to shift capital and labor outside the farming business (Menapace, Colson, and Raffaelli, 2015). Our finding indicates that better instruments or better communication for off-farm risk management tools might be needed to allow farmers to diversify also outside of risky on-farm activities.

An increasing acreage of the farm is associated with greater spatial dispersion, likely indicating larger diffusion of the location of farmland, implying that farmers have already reduced some production risk. Our results show that these farmers are less likely to engage in a greater share of on-farm risk management strategies related to agricultural production compared to off-farm strategies. Furthermore, we find that an increasing proportion of rented land increases the probability to apply more off-farm risk management strategies compared to on-farm non-agriculture related tools. Thus, we can confirm findings by Velandia et al. (2009) and Mishra and El-Osta (2002) who claim that a higher proportion of rented land is associated with higher risk exposure, lower wealth, means, and incentives to build-up long-term capacities for risk bearing on the farm, resulting in a greater need to spread the risk to a third party.

3.8 Conclusion

In this article, we have contrasted three alternative hypothetical methods for assessing risk preferences that vary in terms of their simplicity and contextual framing and payoff scale. We find that risk preferences are context depending and by framing the widely used MPL in an agricultural context we found significant evidence for it to pertain well to real decision making. Farmers have a number of options in managing agricultural risks and many of them utilize multiple risk management tools simultaneously. However, most literature on factors affecting adoption of multiple risk management tools has not addressed this aspect. It is often implicitly assumed that the decision to adopt one risk management tool is independent of the decision to adopt other risk management tools. In contrast, we show that focusing on risk management portfolios, going beyond single risk management tools, is required. We find that risk averse farmers are more likely to prioritize on-farm risk management strategies over off-farm strategies. Our analysis shows that counter intuitively risk averse farmers are less likely to choose off-farm risk management strategies. Explanations can be found in the novel and innovative nature of some off-farm risk management strategies included, as well as in the fact that for most farmers the farm business (or yield) is considered as in irreplaceable commodity that cannot be valued in marketable terms. In addition, our findings contribute to solve this puzzle by showing that risk averse farmers do not choose no risk management as an alternative but focus on on-farm measures. Further research should abstain from focusing on the analysis of single risk management tools but further develop a holistic approach including the whole portfolio of risk management tools applied by farmers. As we collected the data analyzed in this article via a self-deducted paper pencil survey, the information collected is limited to the main farm operator. Nevertheless, there is evidence that the farming couple is deciding on the household risk management strategy jointly (see e.g. Benjamin and Kimhi, 2006). Consequently, there might be additional factors influencing the farmer's risk management choice not considered in this analysis (e.g. demographic characteristics of the farmer's spouse including risk preferences, occupation, age etc.). Furthermore, there are additional factors influencing the farmer's risk management choice we were not able to collect in the survey due to the high sensitivity of information in the specific context of the case study area (e.g. exact location or income). Moreover, we find that age, risk perception, subjective numeracy, farm succession, farm size and the proportion of rented land play a role when explaining farmers' risk behavior. Extension educators and other risk management information providers in the survey area may be able to tailor their programs better, based on the results gained from this analysis.

3.9 References

Abdellaoui, Mohammed, Ahmed Driouchi, and Olivier L'Haridon. 2011. "Risk aversion elicitation: reconciling tractability and bias minimization." *Theory and Decision* 71 (1):63-80.

Anderson, Lisa R., and Jennifer M. Mellor. 2009. "Are risk preferences stable? Comparing an experimental measure with a validated survey-based measure." *Journal of Risk and Uncertainty* 39 (2):137-160.

Benjamin, Catherine, and Ayal Kimhi. 2006. "Farm work, off-farm work, and hired farm labour: estimating a discrete-choice model of French farm couples' labour decisions." *European Review of Agricultural Economics* 33 (2):149-171.

Bishu, Kinfe G., Seamus O'Reilly, Edward Lahiff, and Bodo Steiner. 2016. "Cattle farmers' perceptions of risk and risk management strategies: evidence from Northern Ethiopia." *Journal of Risk Research*:1-20.

Bommier, Antoine, and François Le Grand. 2014. "Too Risk Averse to Purchase Insurance? A theoretical glance at the annuity puzzle." *Journal of Risk and Uncertainty* 48 (2):135-166.

Bougherara, Douadia, Xavier Gassmann, and Laurent Piet. 2011. "A structural estimation of French farmers' risk preferences: an artefactual field experiment." *Working Paper SMART – LERECO* 11 (06).

Charness, Gary, Uri Gneezy, and Alex Imas. 2013. "Experimental methods: Eliciting risk preferences." *Journal of Economic Behavior & Organization* 87:43–51.

Cook, Philip J., and Daniel A. Graham. 1977. "The Demand for Insurance and Protection: The Case of Irreplaceable Commodities." *The Quarterly Journal of Economics* 91 (1):143-156.

Crosetto, Paolo, and Antonio Filippin. 2013. "The "bomb" risk elicitation task." *Journal of Risk and Uncertainty* 47 (1):31-65.

de Mey, Yann, Erwin Wauters, Dierk Schmid, Markus Lips, Mark Vancauteren, and Steven van Passel. 2016. "Farm household risk balancing: empirical evidence from Switzerland." *European Review of Agricultural Economics* 43 (4).

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, and Gert G. Wagner. 2011. "Individual risk attitudes: Measurement, determinants, and behavioral consequences." *Journal of the European Economic Association* 9 (3):522–550.

Eckel, Catherine C., and Philip J. Grossman. 2008. "Forecasting risk attitudes: An experimental study using actual and forecast gamble choices." *Journal of Economic Behavior & Organization* 68 (1):1-17.

Fagerlin, Angela, Brian J. Zikmund-Fisher, Peter A. Ubel, Aleksandra Jankovic, Holly A. Derry, and Dylan M. Smith. 2007. "Measuring numeracy without a math test: development of the Subjective Numeracy Scale." *Medical Decision Making* 27 (5):672–680.

Finger, Robert, and Niklaus Lehmann. 2012. "The influence of direct payments on farmers' hail insurance decisions." *Agricultural Economics* 43 (3):343-354.

Flaten, Ola, Gudbrand Lien, Matthias Koesling, Paul Steinar Valle, and Martha Ebbesvik. 2005. "Comparing risk perceptions and risk management in organic and conventional dairy farming: empirical results from Norway." *Livestock Production Science* 95 (1):11–25.

Gneezy, Uri, and Jan Potters. 1997. "An Experiment on Risk Taking and Evaluation Periods." *The Quarterly Journal of Economics* 112 (2):631-645.

Hansson, Helena, and Carl Johan Lagerkvist. 2012. "Measuring farmers' preferences for risk: a domain-specific risk preference scale." *Journal of Risk Research* 15 (7):737-753.

Harrison, Glenn W., Morten I. Lau, and Elisabet E. Rutström. 2007. "Estimating risk attitudes in denmark: A field experiment." *The Scandinavian Journal of Economics* 109 (2):341-368.

Harrison, Glenn W., John A. List, and Charles Towe. 2007. "Naturally occurring preferences and exogenous laboratory experiments: A case study of risk aversion." *Econometrica: Journal of the Econometric Society* 75 (2):433-458.

Heinemann, Frank. 2008. "Measuring risk aversion and the wealth effect." In *Risk aversion in experiments*, edited by James C. Cox and Glenn W. Harrison, 293-313. online: 08 Mar 2015: Emerald Group Publishing Limited.

Hellerstein, Daniel, Nathaniel Higgins, and John Horowitz. 2013. "The predictive power of risk preference measures for farming decisions." *European Review of Agricultural Economics* 40 (5):807–833.

Herberich, David H., and John A. List. 2012. "Digging into background risk: experiments with farmers and students." *American Journal of Agricultural Economics* 94 (2):457-463.

Holden, Stein T., and John Quiggin. 2016. "Climate risk and state-contingent technology adoption: shocks, drought tolerance and preferences." *European Review of Agricultural Economics*.

Holt, Charles A., and Susan K. Laury. 2002. "Risk aversion and incentive effects." *American Economic Review* 92 (5):1644–1655.

Just, Richard E., Linda Calvin, and John Quiggin. 1999. "Adverse selection in crop insurance: Actuarial and asymmetric information incentives." *American Journal of Agricultural Economics* 81 (4):834-849.

Kahneman, Daniel, and Amos Tversky. 1979. "Prospect theory: An analysis of decision under risk." *Econometrica: Journal of the Econometric Society*:263-291.

Maart-Noelck, Syster C., and Oliver Musshoff. 2013. "Measuring the risk attitude of decision-makers: are there differences between groups of methods and persons?" *Australian Journal of Agricultural and Resource Economics* 58 (3):336–352.

McNamara, Kevin T., and Christoph Weiss. 2005. "Farm Household Income and On- and Off-Farm Diversification." *Journal of Agricultural and Applied Economics* 37 (1):37-48.

Menapace, Luisa, Gregory Colson, and Roberta Raffaelli. 2013. "Risk aversion, subjective beliefs, and farmer risk management strategies." *American Journal of Agricultural Economics* 95 (2):384–389.

Menapace, Luisa, Gregory Colson, and Roberta Raffaelli. 2015. "A comparison of hypothetical risk attitude elicitation instruments for explaining farmer crop insurance purchases." *European Review of Agricultural Economics* 43 (1):113-135.

Meraner, Manuela, Wim Heijman, Tom Kuhlman, and Robert Finger. 2015. "Determinants of farm diversification in the Netherlands." *Land Use Policy* 42:767-780.

Meuwissen, Miranda P. M., Rudd B. M. Huirne, and Brian J. Hardaker. 2001. "Risk and risk management: an empirical analysis of Dutch livestock farmers." *Livestock Production Science* 69 (1):43–53.

Meyer, Jack. 2002. "Expected Utility as a Paradigm for Decision Making in Agriculture." In *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*, edited by Richard E. Just and Rulon D. Pope, 3-19. Boston USA: Springer US.

Mishra, Ashok K., and Hisham S. El-Osta. 2002. "Managing risk in agriculture through hedging and crop insurance: what does a national survey reveal?" *Agricultural Finance Review* 62 (2):135-148.

Musser, Wesley N., and George F. Patrick. 2002. "How Much does Risk Really Matter to Farmers?" In *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*, edited by Richard E. Just and Rulon D. Pope, 537-556. Boston USA: Springer US.

Potter, Clive, and Matt Lobley. 1996. "The farm family life cycle, succession paths and environmental change in Britain's countryside." *Journal of Agricultural Economics* 47 (1-4):172-190.

Reynaud, Arnaud, and Stéphane Couture. 2012. "Stability of risk preference measures: results from a field experiment on French farmers." *Theory and Decision* 73 (2):203–221.

Savage, Leonard J. 1972. *The Foundations of Statistics*. New York USA: Courier Corporation.

Schaper, Christian, Hauke Bronsema, and Ludwig Theuvsen. 2012. *Risikomanagement in der Landwirtschaft*. Schriftenreihe des Landesamtes für Umwelt, Landwirtschaft und Geologie 36, 36.

Shapiro, B. I., and Wade B. Brorsen. 1988. "Factors Affecting Farmers' Hedging Decisions." *North Central Journal of Agricultural Economics* 10 (2):145-153.

Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein. 1982. "Why Study Risk Perception?" *Risk Analysis* 2 (2):83–93.

van der Ploeg, Jan Douwe, and Dirk Roep. 2003. "Multifunctionality and rural development: the actual situation in Europe." In *Multifunctional agriculture: a new paradigm for European agriculture and rural development*, edited by Guido van Huylenbroeck and Guy Durand, 37-53. Hampshire UK: Ashgate.

van Raaij, Fred W. 1981. "Economic psychology." *Journal of Economic Psychology* 1 (1):1–24.

van Winsen, Frankwin, Yann de Mey, Ludwig Lauwers, Steven van Passel, Mark Vancauteren, and Erwin Wauters. 2014. "Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies." *Journal of Risk Research* 19 (1):56-78.

Velandia, Margarita, Roderick M. Rejesus, Thomas O. Knight, and Bruce J. Sherrick. 2009. "Factors Affecting Farmers' Utilization of Agricultural Risk Management

Tools: The Case of Crop Insurance, Forward Contracting, and Spreading Sales." *Journal of Agricultural and Applied Economics* 41 (01):107-123.

Verbeek, Marno. 2008. *A guide to modern econometrics*. Vol. 4. New York USA: John Wiley & Sons.

Weber, Elke U., Ann-Renee Blais, and Nancy E. Betz. 2002. "A domain-specific risk-attitude scale: Measuring risk perceptions and risk behaviors." *Journal of Behavioral Decision Making* 15 (4):263–290.

Weesie, Jeroen. 1999. "Seemingly unrelated estimation and the cluster-adjusted sandwich estimator." *Stata Technical Bulletin* 52:34-47.

Zikmund-Fisher, Brian J., Dylan M. Smith, Peter A. Ubel, and Angela Fagerlin. 2007. "Validation of the Subjective Numeracy Scale: Effects of Low Numeracy on Comprehension of Risk Communications and Utility Elicitations." *Medical Decision Making* 27 (5):663-671.

3.10 Appendix 3.A

Sources of risk

Table 3.A.1: Sources of risk included in the survey to elicit overall risk perception scores

Sources of risk
Market- and price risks
Price volatility on sales market
Price volatility on procurement market
Increasing tenure prices
Increasing fodder prices
Weakening of producers due to increasing purchaser power
Institutional risks
Further decreasing of EU direct payments
Tightening of cross compliance
Increasing regulations for animal breeding (e.g. animal welfare regulations)
Increasing regulations for crop production (e.g. environmental protection regulations)
Reduction of EU market supporting measures (e.g. tariffs)
Further greening of the agricultural policy
Limitations to agricultural construction law
Disappearance of markets
Production risks
Yield volatility due to climate change
Yield loss due to climatic extreme events (e.g. flood, hail)
Epidemic animal diseases
Difficulties to fight pests and diseases (resistances)
Reduced land availability
Financial risks
Liquidity shortage
Decreasing creditworthiness
Other risks
Limited availability of qualified workforce
Default of the main farm operator
Problems with meeting quality standards
Acceptance problems of livestock farming (e.g. protests against new built stables)
Acceptance problems of arable farming (e.g. monoculture in agriculture)

Contextualized MPL

Instructions (translated from German):

To make sure that you understand the payout structure regarding your participation in this survey, please read the following instructions carefully:

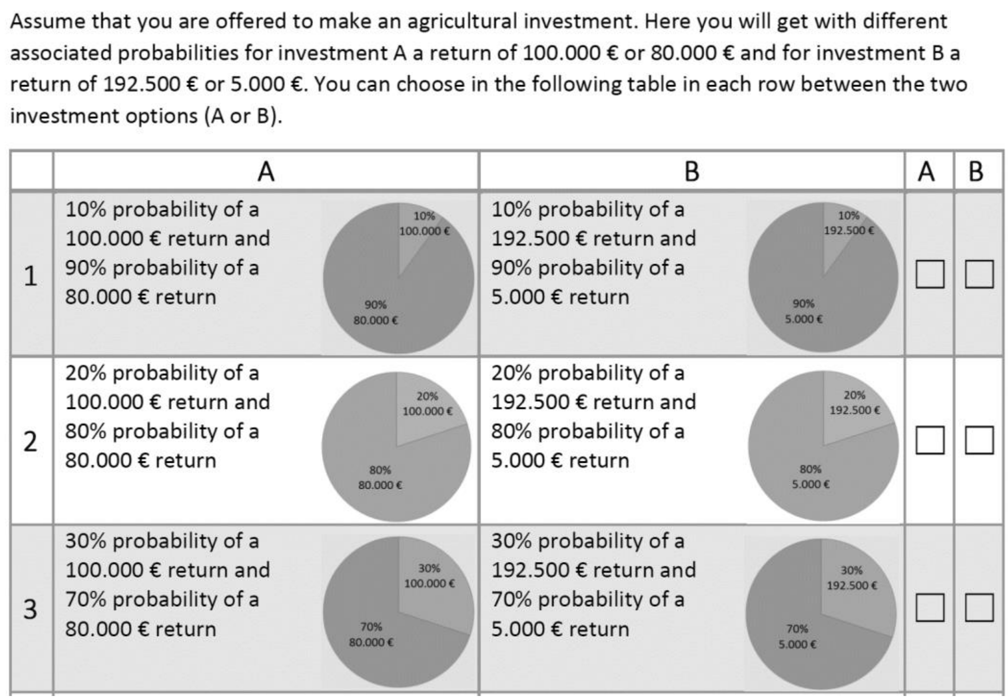
Below you see a table including 10 different decision scenarios (rows) for possible investment outcomes (A and B). Each row of the decision table contains a pair of choices between Option A and Option B. 10 out of 100 participants will be chosen randomly as winners. If you are one of them your payout will be calculated as following:

1) One of the rows is selected at random, and the Option (A or B) that you chose in that row will be used to determine your earnings.

Example: We assume, row 1 was selected randomly and your selected choice is investment A.

2) After one of the decisions has been randomly selected, another random number is chosen to elicit the probability of your payout. This random number determines your earnings for the Option (A or B) that you previously selected for the decision being used.

Example: In row 1 we randomly make a selection out of 10 balls (1 green and 9 blue) to determine your payout. If a blue ball is selected, the amount is 80.000€. The actual payout is divided by 1.000. Thus, you receive a payout of 80€.



Assume that you are offered to make an agricultural investment. Here you will get with different associated probabilities for investment A a return of 100.000 € or 80.000 € and for investment B a return of 192.500 € or 5.000 €. You can choose in the following table in each row between the two investment options (A or B).

	A		B		A	B
1	10% probability of a 100.000 € return and 90% probability of a 80.000 € return	10% 100.000 €; 90% 80.000 €	10% probability of a 192.500 € return and 90% probability of a 5.000 € return	10% 192.500 €; 90% 5.000 €	☐	☐
2	20% probability of a 100.000 € return and 80% probability of a 80.000 € return	20% 100.000 €; 80% 80.000 €	20% probability of a 192.500 € return and 80% probability of a 5.000 € return	20% 192.500 €; 80% 5.000 €	☐	☐
3	30% probability of a 100.000 € return and 70% probability of a 80.000 € return	30% 100.000 €; 70% 80.000 €	30% probability of a 192.500 € return and 70% probability of a 5.000 € return	30% 192.500 €; 70% 5.000 €	☐	☐

Figure 3.A.1: Example visual presentation MPL

Risk management strategies

Table 3.A.2: Risk management strategies included in the survey

On-farm agriculture	N	On-farm non-agriculture	N	Off-farm	N
Risk adapted production (e.g. prudent choice of sowing time)	34	Non-agricultural diversification (e.g. direct sales, tourism, bio energy production)	29	Off-farm work	11
Use of robust or resistant varieties and breeds	47	Holding liquidity reserves	42	Off-farm investments	24
Agricultural diversification (e.g. mixed agriculture)	27	Work harder or cut private expenses	14	Yield insurance	35
Investment in new technologies, that adjusts my production to the weather (e.g. irrigation)	7	Cooperation with other farmers	35	Hail insurance	36
				Multiple risk insurance (e.g. hail + storm + heavy rain + heavy frost)	5
				Business liability insurance + floor-coverage + environmental liability	41
				Legal protection insurance	43
				Trading on the commodity futures exchange	4

Table 3.A.3: Pearson correlation coefficients of risk preferences elicited with different methods

N = 61[33]	MPL	SA	Ø BS	BSProd	BSMark	BSFin	BSAg
MPL	1.000						
SA	0.649***	1.000					
Ø BS	0.402***	0.688***	1.000				
BSProd	0.481***	0.686***	0.883***	1.000			
BSMark	0.335***	0.523***	0.845***	0.738***	1.000		
BSFin	0.253**	0.536***	0.782***	0.531***	0.455***	1.000	
BSAg	0.311**	0.605***	0.914***	0.768***	0.739***	0.634***	1.000

** Significant at the 5% level, *** significant at the 1% level

[33] Note that we excluded three non-responding farmers for this analysis (two missing for the MPL, one missing for the SA).

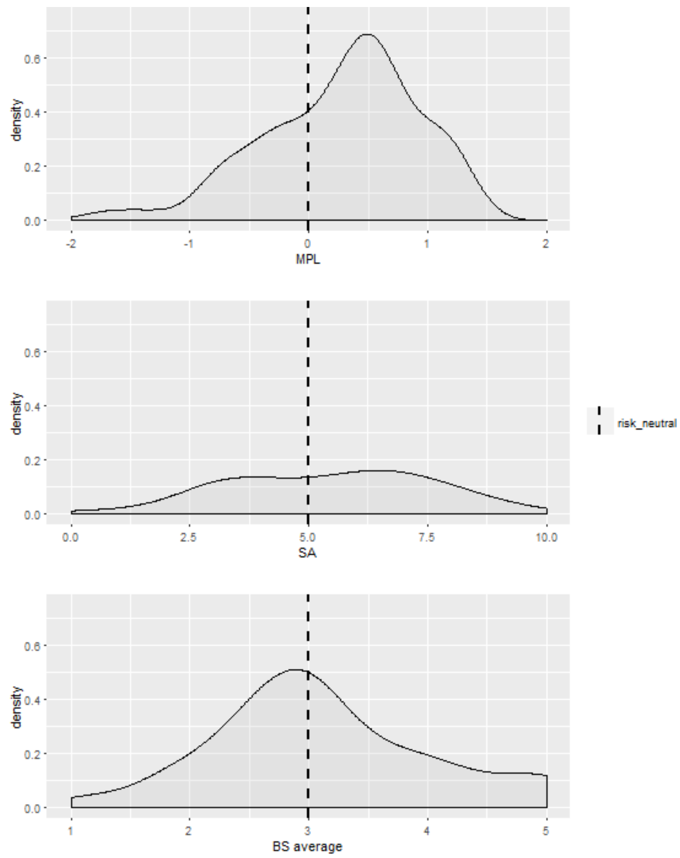


Figure 3.A.2: Kernel density plots of three different risk preference elicitation methods

Table 3.A.4: Spearman correlation coefficients of risk preferences elicited with different methods and risk perception in different domains

N = 60[34]	MPL	SA	Ø BS	BSProd	BSMark	BSFin	BSAg	PerMarkRisk	PerPolRisks	PerProdRisk	PerFinRisk	PerOtherRisk
MPL	1.000											
SA	0.724***	1.000										
Ø BS	0.456***	0.674***	1.000									
BSProd	0.500***	0.679***	0.850***	1.000								
BSMark	0.391***	0.500***	0.799***	0.682***	1.000							
BSFin	0.315**	0.540***	0.744***	0.499***	0.411***	1.000						
BSAg	0.384***	0.599***	0.903***	0.747***	0.695***	0.588***	1.000					
PerMarkRisk	0.083	0.089	0.063	0.078	0.014	0.001	0.051	1.000				
PerPolRisks	0.173	0.126	0.142	0.123	0.045	0.066	0.090	0.539***	1.000			
PerProdRisk	0.079	0.026	-0.013	-0.044	-0.004	0.007	-0.067	0.379***	0.483***	1.000		
PerFinRisk	-0.107	-0.217*	-0.124	-0.078	-0.124	-0.241*	-0.104	0.467***	0.251*	0.387***	1.000	
PerOtherRisk	-0.090	-0.093	-0.075	-0.107	-0.087	-0.056	-0.125	0.411**	0.543***	0.472***	0.321**	1.000

[34] Note that we have excluded four non-responding farmers for this analysis (two missing for the MPL, one missing for the SA, one missing for the risk perception).

Table 3.A.5: Multinomial logit estimates for MPL, SA and average BS

	MPL		SA		Ø BS	
N = 56	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture
Farmer characteristics						
Risk aversion	2.564* (1.314)	0.304 (0.818)	-0.046 (0.422)	0.448* (0.229)	1.233 (0.982)	1.712* (0.855)
Age	-1.503* (0.804)	0.737 (0.520)	-1.259 (0.769)	0.723 (0.577)	-1.579* (0.875)	0.156 (0.637)
Age^2	0.018** (0.009)	-0.008 (0.006)	0.015* (0.009)	-0.008 (0.006)	0.019* (0.010)	-0.002 (0.007)
Educ	0.611 (0.528)	-0.415 (0.415)	1.280 (0.812)	-0.523 (0.511)	1.072* (0.647)	-0.763 (0.563)
Optim	-0.411 (0.874)	-0.530 (0.631)	-0.109 (0.908)	-0.434 (0.487)	0.469 (0.802)	0.157 (0.536)
SN	4.881*** (1.855)	1.821 (1.121)	4.382** (1.770)	1.724* (0.940)	4.446*** (1.452)	1.539* (0.802)
AgricTrain	-0.122 (0.585)	0.408 (0.478)	-0.391 (0.705)	0.259 (0.437)	-0.573 (0.641)	0.205 (0.458)
PerMarkRisk	-1.397** (0.556)	-0.238 (0.176)	-1.386** (0.543)	-0.309* (0.174)	-1.526*** (0.570)	-0.434* (0.237)
PerPolRisks	0.158 (0.316)	0.138 (0.188)	0.319 (0.301)	0.125 (0.198)	0.266 (0.284)	0.157 (0.219)
PerProdRisk	-0.186 (0.244)	-0.089 (0.173)	-0.133 (0.253)	-0.123 (0.170)	-0.186 (0.263)	-0.103 (0.196)
PerFinRisk	-0.184 (0.187)	0.052 (0.128)	-0.321 (0.263)	0.130 (0.140)	-0.177 (0.241)	0.193 (0.189)
PerOtherRisk	0.558 (0.420)	0.009 (0.252)	0.486 (0.375)	-0.017 (0.239)	0.588 (0.435)	-0.017 (0.249)
Optim	13.802*** (4.605)	3.159** (1.414)	12.571*** (4.070)	2.844** (1.139)	12.555*** (3.388)	3.193** (1.259)
Household characteristics						
WF	0.097 (0.763)	0.396 (0.547)	0.166 (0.880)	0.174 (0.575)	0.332 (0.713)	0.569 (0.466)
FarmSuc	-1.052 (2.176)	2.801 (1.782)	-1.871 (2.637)	2.824* (1.618)	-1.481 (1.851)	2.483** (1.184)
HHS	-0.582 (0.549)	0.249 (0.372)	-0.418 (0.488)	0.197 (0.404)	-0.401 (0.519)	0.262 (0.439)
Farm characteristics						
AgricArea	-0.031* (0.018)	0.003 (0.006)	-0.028 (0.020)	0.003 (0.006)	-0.032* (0.019)	0.002 (0.005)
PropRentLand	2.164 (4.179)	-7.298* (2.683)	2.136 (3.845)	-6.471*** (2.323)	1.578 (3.968)	-7.857*** (2.818)
LivePig	0.001 (0.001)	0.001 (0.000)	0.000 (0.001)	0.001* (0.000)	0.001 (0.001)	0.001** (0.001)
LiveCattle	0.014 (0.008)	0.001 (0.005)	0.010 (0.007)	0.004 (0.004)	0.013* (0.007)	0.006 (0.004)
Constant	18.177 (17.544)	-19.537 (12.547)	9.972 (15.241)	-18.306 (14.544)	14.856 (16.923)	-7.730 (14.013)
Wald Chi2(40)		74.3		73.56		86.98
Log pseudolikelihood		-33.895995		-34.297416		-34.121888
Prob > chi2 =		0.0013		0.0010		0.0000

Table 3.A.6: Multinomial logit estimates for BS production, BS marketing and prices, BS finances and BS agriculture generally

	BSProd		BSMark		BSFin		BSAg	
N = 56	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture	On-farm agriculture	On-farm non-agriculture
Farmer characteristics								
Risk aversion	0.741 (0.847)	0.766 (0.546)	0.502 (0.720)	1.365* (0.721)	1.532** (0.731)	0.816 (0.675)	-0.615 (0.748)	0.900 (0.607)
Age	-1.422* (0.849)	0.459 (0.503)	-1.340* (0.766)	0.259 (0.502)	-1.784** (0.731)	0.363 (0.669)	-1.592* (0.888)	0.216 (0.648)
Age^2	0.017* (0.010)	-0.005 (0.005)	0.016* (0.009)	-0.003 (0.005)	0.021** (0.008)	-0.004 (0.007)	0.019* (0.010)	-0.002 (0.007)
Educ	1.260** (0.632)	-0.393 (0.417)	1.097 (0.719)	-0.696 (0.479)	1.020 (0.743)	-0.597 (0.649)	1.459** (0.645)	-0.473 (0.401)
Optim	0.238 (0.771)	-0.252 (0.530)	0.208 (0.928)	-0.055 (0.517)	1.118 (0.696)	0.084 (0.720)	-0.125 (1.255)	-0.157 (0.524)
SN	4.046*** (1.531)	1.483* (0.865)	4.350*** (1.626)	1.848** (0.745)	4.234*** (1.625)	1.676 (1.036)	4.916*** (1.548)	1.375** (0.724)
AgricTrain	-0.589 (0.647)	0.221 (0.458)	-0.546 (0.608)	-0.099 (0.464)	-0.935 (0.623)	0.246 (0.502)	-0.072 (0.694)	0.295 (0.420)
PerMarkRisk	-1.334*** (0.475)	-0.284* (0.165)	-1.457** (0.642)	-0.367* (0.222)	-1.561** (0.449)	-0.431** (0.207)	-1.434 (0.535)	-0.208 (0.173)
PerPolRisks	0.188 (0.280)	0.103 (0.195)	0.307 (0.319)	0.120 (0.230)	0.347 (0.250)	0.274 (0.192)	0.372 (0.273)	0.098 (0.188)
PerProdRisk	-0.154 (0.246)	-0.064 (0.168)	-0.101 (0.237)	0.000 (0.219)	-0.230 (0.282)	-0.145 (0.209)	-0.124 (0.237)	-0.043 (0.187)
PerFinRisk	-0.262 (0.243)	0.080 (0.138)	-0.250 (0.248)	0.091 (0.137)	-0.126 (0.251)	0.171 (0.202)	-0.317 (0.249)	0.076 (0.126)
PerOtherRisk	0.620 (0.433)	0.037 (0.231)	0.537 (0.434)	-0.028 (0.265)	0.468 (0.396)	-0.129 (0.262)	0.397 (0.464)	-0.090 (0.229)
Optim	11.862*** (3.137)	2.687** (1.112)	12.493*** (4.161)	2.992** (1.179)	12.154*** (3.323)	2.918** (1.262)	14.086*** (3.587)	2.856*** (1.167)
Household characteristics								
WF	0.132 (0.724)	0.412 (0.515)	0.199 (0.817)	0.506 (0.438)	-0.032 (0.802)	0.474 (0.573)	-0.070 (0.868)	0.335 (0.466)
FarmSuc	-1.340 (1.884)	2.661* (1.503)	-1.594 (2.012)	2.293** (1.143)	-0.933 (1.617)	2.428 (1.650)	-2.627 (2.089)	2.037 (1.293)
HHS	-0.357 (0.500)	0.238 (0.396)	-0.453 (0.493)	0.117 (0.356)	-0.482 (0.553)	0.274 (0.494)	-0.352 (0.474)	0.230 (0.435)
Farm characteristics								
AgricArea	-0.030 (0.021)	0.001 (0.005)	-0.027 (0.017)	0.001 (0.005)	-0.027 (0.019)	0.005 (0.006)	-0.025 (0.018)	0.003 (0.004)
PropRentLand	2.916 (4.060)	-6.034*** (2.206)	1.568 (4.032)	-7.236*** (2.478)	2.295 (3.725)	-7.374** (2.903)	1.404 (3.762)	-6.865*** (2.437)
LivePig	0.001 (0.001)	0.001** (0.000)	0.000 (0.001)	0.001** (0.000)	0.001 (0.002)	0.001* (0.001)	0.000 (0.001)	0.001** (0.000)
LiveCattle	0.012 (0.007)	0.003 (0.004)	0.010 (0.007)	0.007 (0.004)	0.017** (0.007)	0.003 (0.004)	0.009 (0.008)	0.005 (0.004)
Constant	11.118 (15.486)	-14.949 (12.029)	11.691 (15.813)	-8.771 (11.801)	21.273 (13.913)	-9.818 (16.414)	14.824 (17.644)	-8.790 (12.858)
Wald Chi2(40)		106.14		86.47		96.38		104.62
Log pseudolikelihood		-35.257268		-33.980495		-33.628467		-33.759636
Prob > chi2 =		0.0000		0.0000		0.0000		0.0000

Chapter 4

Determinants and motives for agritourism activities: A German case study*

* Meraner, M., K. Holtmann and R. Finger (under review)

Abstract

Farm diversification is of key relevance for the agricultural sector and for rural development. We investigate the determinants and motives for agritourism activities. More specifically, we focus on four aspects, namely i) motives for agritourism diversification, ii) the role of farmwomen in the agritourism venture, iii) farm and farmers' characteristics and iv) farmers' risk preferences. Our analysis is based on 33 interviews conducted with agritourism and non-agritourism farmers located within and in the surroundings of the city of Muenster, Germany. Our results show that the uptake of agritourism is mainly driven by pull motives (e.g. taking advantage of market opportunities or joy of working in agritourism). Focusing on the role of farmwomen, we find that even though decisions are often made jointly, farmwomen are more often responsible for the realization of activities than the initialization and planning. Comparing agritourism and non-agritourism farms, we find the former to be smaller, more diversified and more often run by female farm operators. Furthermore, we find agritourism farmers to be more risk averse. Agritourism creates a source of income that is independent from unstable agricultural income and thus contributes to smooth volatile agricultural income.

Keywords: Farm diversification, agritourism, motives, decision making, risk preferences

JEL classification: Q12, Z30

4.1 Introduction

Farm diversification is a key component of farm-survival and rural development in many countries of the world and allows farmers to stabilize or increase their income (e.g. Barrett, Reardon, and Webb, 2001, McNamara and Weiss, 2005). For instance, one out of three farmers in the European Union has diversified into non-agricultural activities (European Parliamentary Research Service, 2016), which also represents the promotion of farm-diversification in the European Union since the 1980s with subsidies and support for agricultural diversification being established (Ilbery and Bowler, 1998). Among various diversification measures, agritourism is of central relevance as it also contributes to rural development and improves economic opportunities and accessibility in disadvantaged rural regions (European Commission, 1990). Farm diversification in the broad sense and agritourism in the narrow implies that farms reallocate resources (e.g. capital or labor) away from the production of conventional crops and livestock to generate income (McInerney and Turner, 1991, Ilbery, 1991). Our analysis focusses on farmers' motives to take up agritourism activities, which we define as activities that incorporate both a working farm environment and a commercial tourism component (Weaver and Fennell, 1997).

Four streams of literature have investigated farmers' decisions to engage in agritourism. First, there is a focus on stated motives of farm managers behind farm diversification in order to understand all determinants leading to agritourism (Haugen and Vik, 2008, McGehee and Kim, 2004, Ollenburg and Buckley, 2007). Second, there is a large body of literature focusing on finding observable farm, farmer and household characteristics determining the agritourism decision (Meraner et al., 2015, McNally, 2001, Ilbery et al., 1998, McNamara and Weiss, 2005, Mishra, El-Osta, and Sandretto, 2004, Bagi and Reeder, 2012). Third, some studies focus on agricultural diversification including agritourism as a farm risk management strategy used to smooth volatile agricultural income (Mishra, El-Osta, and Sandretto, 2004, Meuwissen, Huirne, and Hardaker, 2001, Kostov and Lingard, 2003). This literature builds on the hypothesis that farmer's choice to engage in agritourism activities is driven by individual risk preferences. Fourth, many studies focus specifically on the role of farmwomen in the agritourism business (Sharpley and Vass, 2006, Hansson et al., 2013, Hjalager, 1996, McGehee, Kim, and Jennings, 2007). Hansson et al. (2013) emphasis on the role of farmwomen in different stages of the agritourism business (planning and managing). Furthermore, Haugen and Vik (2008) and Brandth and Haugen (2007) focus on the gendered nature of different agritourism activities leading to differences in the intensity of farmwomen's participation in different agritourism activities.

Despite this rich set of literature, no study has combined all four aspects. More specifically, no study has provided a coherent analysis of farmers' motives, farm and farmers' characteristics and risk preferences driving agritourism decisions. We contribute filling gaps in the literature by combining the four dimensions in our analysis. To this end, we conduct interviews with German farmers to understand farmers' motives influencing the agritourism decision. Moreover, we obtain farm, farmer and household characteristics and elicit farmers' risk preferences using experimental risk preference elicitation methods. For the latter, farmers with and without agritourism are compared with each other to identify determinants characterizing farms diversifying in agritourism. Furthermore, we analyze the specific role of farmwomen in different stages of the agritourism business for a variety of different agritourism activities. Against this background, this study focuses on answering the following research questions: i) Which motives underlie the decision to engage in agritourism? ii) To what extend are farmwomen participating in the initialization and implementation process of agritourism activities? iii) Which, if any, farm, farmer and household characteristics including risk preferences are deterministic of agritourism farms? Findings to these research questions can support the development of more tailored extension services and better tailored policies aiming to support farm diversification into agritourism.

The remainder of this paper is organized as follows. The subsequent section presents the determinants of agritourism. This is followed by a description of the methodology of data collection and data. Subsequently, we present the results based on our research questions and a discussion of our analysis.

4.2 Theoretical framework

In this section, we discuss the theoretical frameworks as well as the key literature underlying the four blocks of relevance for our analysis, i.e. i) motives for agritourism diversification, ii) the role of farmwomen in the agritourism venture, iii) farm and farmers' characteristics and iv) farmers' risk preferences. Based on these theoretical frameworks, aspects for the operationalization in our interviews are derived.

4.2.1 Motives for agritourism initiation

Defining the establishment of a new venture outside traditional agriculture as an entrepreneurial activity (McElwee, 2008, Segal, Borgia, and Schoenfeld, 2005), farmers are either pushed or pulled into the startup of new ventures. In order to group the various motives behind the farmers' decision for agritourism entrepreneurship literature suggests the distinction between “opportunity driven” (pull factor) or “necessity driven” (push factor) decisions. Thus, push factors comprise a dissatisfaction with the current situation and agricultural business environment, where the farmer is pushed to activities outside agricultural production by the necessity to seek extra income, become self-employed or decrease agricultural risks (Busby and Rendle, 2000, Hansson et al., 2013). In contrast, pull factors include motives based on a favorable economic environment outside traditional agriculture. This includes the existence of emerging local demand or markets, or excess labor capacities.

In order to describe motives in a more refined way, further sub-categories are often used (e.g. Nickerson, Black, and McCool, 2001, McGehee and Kim, 2004, Barbieri, 2009, Ollenburg and Buckley, 2007, Di Domenico and Miller, 2012). Based on this literature we classify the set of motives included in our study into four categories, namely: i) farm-survival, ii) intrinsic, iii) extrinsic, and iv) family motives. *Farm-survival motives* are mainly necessity driven. Some studies find that the need of extra income and the insufficient income from agriculture are the main motives of farmers engaging in agritourism (McGehee and Kim, 2004, Barbieri, 2009). Furthermore, Nickerson, Black, and McCool (2001) and McGehee and Kim (2004) show that optimal usage of farm resources and minimizing the fluctuations in agricultural income are important motives. Hansson et al. (2013) and Barbieri (2009) additionally include the farmers' wish to reduce debts in the business. *Intrinsic motives* are concerned with the farmers' lifestyle. Vik and McElwee (2011) find that the wish to create something i.e. learn and acquire new skills is an important motive for agritourism farmers. Barbieri (2009) and Di Domenico and Miller (2012) find that the wish to continue farming and enhancement of the personal and family quality of life to be important motives for farmers. Furthermore, joy in the work, passion to work with people and turning a hobby into a career are motives included in this category (Vik and McElwee, 2011, Ollenburg and Buckley, 2007). Medhurst and Segrave (2007) claim that independence, self-sufficiency, flexibility and to work at home are important intrinsic motives. *Extrinsic motives* are those focusing on the external demand i.e. opportunity based factors, determined externally (e.g. by the geographical, political, or demand environment). Barbieri (2009) and Hansson et al. (2013) find evidence that motivation for agritourism farmers is driven by market needs and growth opportunities outside traditional agriculture (possibly stimulated by the farms location). Furthermore, Nickerson, Black, and McCool (2001) claim that farmers can be motivated by governmental incentives (e.g. taxes or subsidies). Hansson et al. (2013) also considers the wish to gain independence from agricultural policy. *Family motives* include those motives concerned with the farm family. Hansson et al. (2013) and Barbieri (2009) highlight the importance of employment for family members (and opportunities to take better care of the children and household). Furthermore, Ollenburg and Buckley (2007) and Hansson et al. (2013) include the need to keep the business in family ownership and create an employment opportunity for future generations.

4.2.2 Role of farmwomen in the agritourism venture

Agritourism ventures demand flexibility regarding time management between the tourism businesses and farming business thus, agritourism is largely family based, requiring the involvement of the farming couple. In this light Phelan and Sharpley (2011) propose an expansion of the focus on the main farm in entrepreneurial theory to the farmers spouse (i.e. copreneurship). Recent studies in Europe find that the main workload of the agritourism business lies with the female partners of the farm family (Sharpley and Vass, 2006, Nilsson, 2002, Haugen and Vik, 2008, Busby and Rendle, 2000). In an early study Hjalager (1996) argues that agritourism can be a way of making the work of female farm family members profitable as many agritourism activities find their origins among labor traditionally performed by women on the farm. Moreover, Medhurst and Segrave (2007) and McGehee, Kim, and Jennings (2007) underline the importance of agritourism for the women’s financial independence. Yet, Haugen and Vik (2008) argue that the intensity of the involvement of women in tourism activities follows traditional lines, i.e. they find that women are more engaged in accommodation and food-serving than in adventure activities. Furthermore, Hansson et al. (2013) suggest that the spouse’s involvement in agritourism activities changes in the different stages of the creation of the new venture (i.e. initialization/planning and realization/managing). Next to investigating for the relevance of female farm managers for the uptake of agritourism activities, we explicitly obtain information on the involvement of farmwomen in the initialization and the realization of agritourism activities at the farm.

4.2.3 Farm, farmer and household characteristics

The extent to which resources are allocated to the nonagricultural income activities is influenced by the farms given external decision making environment as well as internal factors as discussed above (Ilbery, 1991, Evans and Ilbery, 1989).

On the farm business level Haugen and Vik (2008) argue that agritourism is an aspect of an economic survival strategy, ensuring farm survival without the loss of independence trough taking off-farm employment. Thus, we expect that agritourism farms are operated more likely as full time activity. Barbieri (2009) finds that agritourism farms are more likely to have a portfolio of on-farm diversification activities as there are synergistic relationships between agritourism and other activities.

The type of farming is found to be closely linked to the diversification decision. McNally (2001) found that the seasonality of the farming activity influences the diversification decision. Specifically, Meraner et al. (2015) conclude that livestock farms with a constantly high labor demand are less likely to have spare time to develop a diversification strategy off-season.

A very common finding in literature is that farm size has a significant effect on the diversification decision. However, the definition and measurement unit of farm size inconsistent in the literature. McNally (2001) and McNamara and Weiss (2005) suggest that larger farms in terms of average net income and number of livestock units are more likely to be diversified, since they can allocate and exploit available resources more efficiently. Contrarily, Vik and McElwee (2011) and Meraner et al. (2015) find that larger agricultural size in terms of hectares of land, decreases the farms' probability to engage in agritourism, larger farms are more likely to use possible economies of scale and choose a specialization strategy.

The farmers' age has been found to influence the diversification decision. Barbieri (2009) and Meraner et al. (2015) argue that younger farmers have stronger needs to create long-term ties and the need to strengthen the farm business, thus they are more likely to diversify the business. However, Haugen and Vik (2008) find that farmers with agritourism do not start the business at a very young age when financial resources are scarce. Benjamin and Kimhi (2006) find in this context that farm diversification is more attractive for not too young farmers, with a peak for middle-aged farmers. This peak phase is followed by a period of increased income needs, due to family building, with a reduced diversification probability. In a later stage (when the children have left the house), income needs are decreasing and farm diversification is attractive again.

Furthermore, Barbieri (2009) and Haugen and Vik (2008) find that agritourism farmers are more likely to have a higher general education, as well as higher degrees of agricultural education. They argue that higher agricultural education goes alongside with stronger occupational identity with farming as success factor for a profitable business within agritourism (Sharpley and Vass, 2006, Di Domenico and Miller, 2012). Thus, we additionally include the emotional attachment to agriculture in our analysis.

An important factor influencing the agritourism decision on the household level is the availability of family workforce. Mishra, El-Osta, and Sandretto (2004) suggest that larger families have a stronger need to create employment opportunities on the farm, leading to more agricultural diversification. Barbieri (2009) finds that households with adult children at home are more likely to engage in agritourism, thus we include whether the succession of the farm business is secure or not. Furthermore, Haugen and Vik (2008) argue that agritourism is a family based operation and find that married or cohabiting farm couples are more likely to engage in agritourism. A full list of all variables included in our analysis based on the presented literature is found in Table 4.3.

4.2.4 Farmers' risk preferences

Finally, farmers' risk preferences are expected to influence decisions towards agritourism. Farm diversification and agritourism create sources of income that are independent from unstable agricultural income and thus contribute to smooth volatile agricultural income (Mishra, El-Osta, and Sandretto, 2004, Meuwissen, Huirne, and Hardaker, 2001, Kostov and Lingard, 2003). Thus, risk averse farmers are assumed to shift more of their resources away from agricultural production to diversify towards activities such as agritourism in order to reach a reduction of the overall riskiness of household income (McNamara and Weiss, 2005, Hardaker et al., 2004). To elicit farmers' risk preferences in surveys and interviews, a wide set of methodological approaches is available. For instance, there is a growing body of literature on the farmers' decision making focusing on the role of individual risk preferences elicited using experimental risk preference elicitation methods (Meuwissen, Huirne, and Hardaker, 2001, van Winsen et al., 2014, Menapace, Colson, and Raffaelli, 2013). In addition, various self-assessment statements have been used in the literature to elicit farmers' risk preferences. With no method dominating the others and the observation that different methods might even result in contrasting results (Hellerstein, Higgins, and Horowitz, 2013, Reynaud and Couture, 2012, Crosetto and Filippin, 2015, Menapace, Colson, and Raffaelli, 2015), we opted to include three risk preference elicitation methods and compare risk aversion of agritourism farmers and non-agritourism farmers. More specifically, we use a lottery based on a multiple price list following Holt and Laury (2002), a self-assessment of risk preferences (Menapace, Colson, and Raffaelli, 2015) and five agricultural business statements adapted from Meuwissen, Huirne, and Hardaker (2001). In order to reduce the potential to obtain contrasting results, contextualized elicitation methods are used.

4.3 Sampling and data

4.3.1 Sampling and case study area

Agritourism has a long tradition in Germany, latest documents on farm tourism go as far as 150 years back (Nilsson, 2002). Most of the existing German research in the field is focusing on the costal and alpine regions with a high density of agritourism farms (Oppermann, 1996, 1997, Lehner-Hilmer, 1999). Next to natural areas and attractive landscapes, however, also the proximity to urban areas was found to be a contributing factor to observe agritourism activities (Lange et al., 2013, Ilbery, 1991, Le Grand and van Meekeren, 2008). Market proximity is associated with increased demand and marketing opportunities which are found to stimulate peri-urban farmers to identify market niches, innovate and adapt to new demands. Thus, we focus in our analysis on the urban area of the city of Muenster in the state of North-Rhine-Westphalia, which is characterized by a combination of attractive landscapes and large urban areas[36] (Figure 4.1). By including farms in a relatively small area, we control for external factors influencing the diversification decision. Thus, we can assume that factors like infrastructure, soil quality, market opportunities as well as attractiveness of the landscape are similar for all farms in the area (Busby and Rendle, 2000, Pfeifer et al., 2009, Ilbery, 1991, Lange et al., 2013, Walford, 2001).

We used the online platform of the Chamber of Agriculture “Landservice” (http://www.landservice.de) to obtain a list of farms being active in agritourism, which we complemented with internet searches using the activities as key words. As defined above we classify all farms with a commercial tourism component as agritourism farms, this includes accommodation, organizing events, leisure, sport or recreational activities, gastronomy, renting out locations for events and conferences and equestrian businesses (e.g. horseback riding, pension horses). The choice of interview partners followed purposive and snowball approaches. We identified in total 26 farmers

[36] More specifically, we focus on the city of Muenster as well as municipalities within a radius of 25km around the city center comprising the city of Muenster and its eastern surrounding municipalities (Telgte, Everswinkel, Sendenhorst and Drensteinfurt) (Figure 4.1). The dark grey fields in the left map of Figure 4.1 depict the city center of Muenster, whereas the surrounding areas are lighter.

involved with agritourism in the selected area. We retrieved a sample of 17 farms with agritourism activities (four farmers did not respond to the contacting approaches, three where not willing to participate and two had no agricultural activity anymore). Additionally, 16 farmers without agritourism activity where interviewed. Leading to a total sample of 33 interviews and a response rate of 79%. The farm location of interviewed farmers is depicted in Figure 4.1.

The potential interview partners where contacted via phone and e-mail to schedule appointments for on-site computer assisted face-to-face interviews in January 2016. The farms without agritourism activities where selected using snowball sampling. Each interviewed agritourism farmer was asked at the end of the interview to give information on five neighbors who could potentially participate in the study. Out of the five potential future interview partners we selected randomly two, to contact and schedule appointments. This approaches' biggest advantage is that we could interview direct neighbors with seemingly similar external preconditions (i.e. distance to potential markets, attractiveness of the landscape) but different choices of farm management strategies. Additionally, snowball sampling increases the credibility of the research, as participants are involved in the research process and it is cost effective. Nevertheless, when using this sampling method the anonymity between participants cannot be obtained, additionally there might be a bias as participants choose people they know and share the same viewpoint (King and Horrocks, 2010). To interview a large number of farmers we used structured, closed-ended interview questions. Furthermore, the biggest advantage of structured interview questions is the increased reliability of results (King and Horrocks, 2010). The interviews took on average two hours. A pre-test was conducted with five farmers in the area. The survey consisted of four parts including questions on: (1) the farms diversification activities, (2) motives for agritourism, (3) the spouse's involvement with agritourism and (4) the farmer (including risk preferences), the farm household and the farm business.

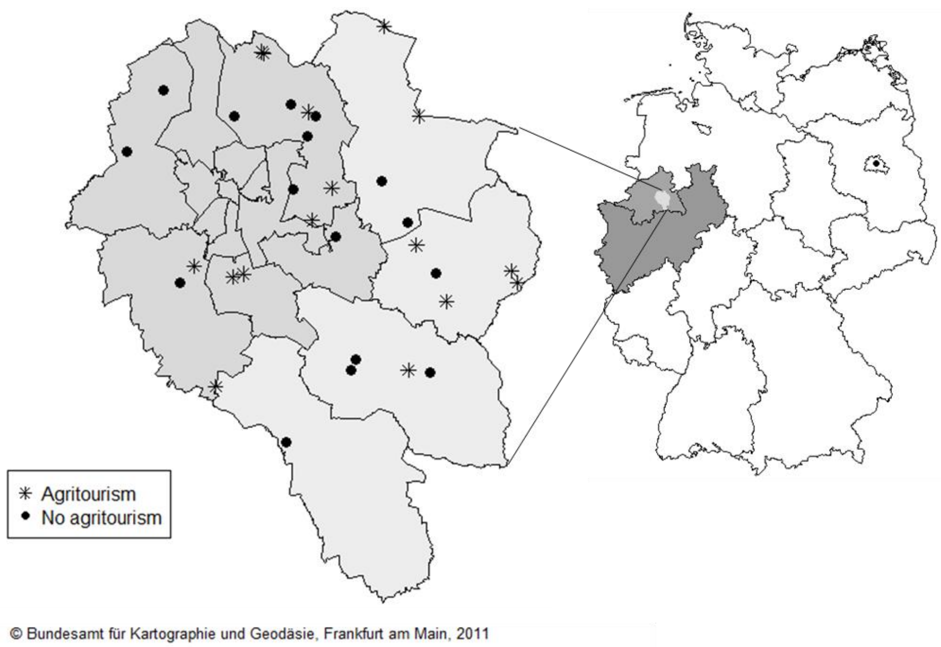


Figure 4.1: Location of case study area

4.3.2 Data description

To analyze a holistic picture of all diversification activities the farmers engage in, we presented a list of 14 on-farm agricultural diversification activities Namely we include five agritourism activities: gastronomy, accommodation, equestrian business, renting out locations, organizing events and ten other on-farm diversification activities: direct marketing, processing of agricultural products, selling Christmas trees, social farming, renewable wind energy, biogas production, photovoltaic systems, agricultural labor for others and woodwork.

To identify the motives underlying farmers' decision to engage in agritourism activities we identified 24 motives that are included in our analysis based on the literature presented in section 4.2.1 these motives are categorized in two ways. First, we distinguish push and pull motives, which allows us to identify general drivers of agritourism engagement. Second, we distinguish these motives in groups of farm-survival, intrinsic, extrinsic and family motives (the complete list is presented in Table 4.1). To capture farmers' motives, we adapted a measurement scale used in other studies in the field (Hansson et al., 2013, Sharpley and Vass, 2006, Barbieri, 2009, Vik and McElwee, 2011, Nickerson, Black, and McCool, 2001). Respondents were asked to indicate on a Likert scale of 1-5 the degree of importance of each motive determining the decision to engage in agritourism. In order to ensure that respondents could distinguish between response options in a meaningful way, the anchors (1) very important; (2) fairly important; (3) moderately important; (4) somewhat important; and (5) not important were used. This scale was chosen based on pre-test results, it is linked to German schooling grades (1 = "very good" and 5 = "deficient"). In order to ease comparability with other research in the field we use inverted motive variables the further analysis. Furthermore, the interviewee explained the scale verbally and presented the full list of motives on paper so that participants could additionally read the motives if necessary. No opt-out alternatives were provided. In Table 4.1 the full list of motives included in the analysis is presented, to ease understanding.

Furthermore, farmers could also freely add in an open question motives they perceived as important and where not included in the list provided.

The role of women in the agritourism business is assessed on the planning and management level of the agritourism business. In particular, the involvement in the initiation/planning and actual realization/management of farmwomen in the agritourism venture was measured on a 5 point Likert scale, adopted from Hansson et al. (2013). More specifically, respondents were presented with the following options: 1. My spouse was solely responsible for initiation/planning of the agritourism venture. 2. My spouse took more part than me in the initiation/planning of the agritourism venture. 3. My spouse and I took equal parts in the initiation/planning of the agritourism venture. 4. My spouse took less part than me in the initiation/planning of the agritourism venture. 5. My spouse did not take part at all in the initiation/planning of the agritourism venture. Accordingly, respondents were asked to indicate their spouses' role in the realization/management of the agritourism venture on a 5 point Likert scale. Keeping in line with other research in the filed the scale was inverted for further analysis so that higher values indicate more involvement of farmwomen. In three cases where the interview partner was female we adapted the responses to capture the role of farmwomen.

The farm, farmer and household characteristics included in this study to compare agritourism and non-agritourism farmers are explained in detail in Table 4.3. We assess risk preferences by using three different methods, namely i) a standard multiple price list (MPL) as introduced by Holt and Laury (2002), ii) a self-assessment of risk preferences (Menapace, Colson, and Raffaelli, 2015) and, iii) five agricultural business statements adapted from Meuwissen, Huirne, and Hardaker (2001).

The MPL is adopted from Holt and Laury (2002) including a list of ten rows with ten unique choices between a safe option (A) and a risky option (B). The number of safe choices is determining the farmers risk preferences ranging from 1 = “very risk averse” to 9 = “very risk loving” (the last row includes a control question not considered in the further analysis of risk preferences). We incentivized the MPL using a realistic payout structure ranging from 5€ to 192.5€, with payouts being made to 10% of the participating farmers (see Maart-Noelck and Musshoff, 2013). Furthermore, we frame the MPL in an agricultural setting to assimilate the real world decision-making context of farmers. An example for the lottery is presented in the Appendix 4.A. For the self-assessment of risk preferences we ask respondents to indicate their general attitude towards risk on a scale from 0 to 10 (adapted from Menapace, Colson, and Raffaelli, 2015): ‘How do you see yourself personally: are you generally willing to take risks, or do you try to avoid them wherever possible? Please indicate your attitude towards risk on a scale from 0 to 10 where 0 means “not at all willing to take risks” and 10 “very willing to take risks”.’ Additionally, we include four business statements measuring the farmers relative risk aversion in four risk dimensions relevant for agriculture as proposed by Meuwissen, Huirne, and Hardaker (2001). Participants are asked to indicate the extend of agreement (1 = “fully agree” to 5 = “don’t agree”) with the following four statements: 1. I am willing to take more risks than my colleagues with respect to production. 2. I am willing to take more risks than my colleagues with respect to marketing. 3. I am willing to take more risks than my colleagues with respect to financial issues. 4. I am willing to take more risks than my colleagues with respect to agriculture generally. In order to incentivize participation we offered all participating farmers a feedback report including the study's results. To analyze the differences in characteristics of agritourism farms and non-agritourism farms we use the Mann-Whitney-Wilcoxon Test. For the analysis and visualizations presented in the article the statistical software R (packages: psych, ggplot2 and maps) is used (R Core Team, 2016). All raw data, codes and the complete survey are available from the authors upon request.

4.4 Results

4.4.1 Motives behind agritourism

Average scores and standard deviations of the measurement items used to capture farmers' motives for starting agritourism are shown in Table 4.1. The strongest motive for all interviewed farmers is the desire to use new market opportunities, followed by the joy to work in agritourism and a passion for working with people. Least important motives are tax reasons and the wish to create employment opportunities for the future generation.

Table 4.1: Descriptive statistics of suggested motives for starting an agritourism activity

		All agritourism farms (N = 17)		Total rank
	pull/push	**Mean**	**SD**	
Farm-survival motives				
Agritourism as a form of extra income	push	4.06	1.14	5
Minimizing income risk stemming from agriculture	push	3.94	1.30	6
Better use of existing or idle capacities, such as facilities, machinery, or area	pull	3.94	1.14	7
Expansion of agricultural production impossible	push	3.24	1.15	14
Insufficient income from agriculture (livelihood)	push	3.18	1.38	15
Reduction of overall business debt	push	1.65	1.00	21
Average of all farm-survival motives		**3.33**	**0.42**	
Intrinsic motives				
Joy to work in agritourism	pull	4.29	0.92	2
Passion for working with people	pull	3.71	0.92	3
Desire to pursue personal interests and realize your own interests	pull	3.12	1.54	9
Independence, self-sufficiency, flexibility	pull	3.18	1.47	10
Desire to learn and acquire new skills	pull	4.24	0.75	11
An opportunity to continue to operate the business (desire to keep working as a farmer)	push	3.69	0.53	12
Desire to work at home, merge workplace with home	pull	3.76	1.15	16
Turn your hobby into a career	pull	3.59	1.37	18
Average of all intrinsic motives		**4.29**	**0.92**	
Family motives				
Putting free family workforce to use	push	3.18	1.38	17
A way to keep the business in family ownership	push	3.00	1.27	19
Ability to work from home to take better care of children and household	pull	2.06	1.25	20
Create an employment opportunity for future generations	push	1.18	0.53	23
Average of all family motives		**2.35**	**0.64**	

Table 4. 1 cont.: Descriptive statistics of suggested motives for starting an agritourism activity

		All agritourism farms (N = 17)		Total rank
	pull/push	**Mean**	**SD**	
Extrinsic motives				
Use market opportunities (e.g. access to new markets, higher demand)	pull	4.53	0.80	1
Location of farm is convenient for agritourism	pull	4.12	1.27	4
Growth opportunities/potential for business bigger aside from traditional agricultural production	pull	3.82	1.29	8
Gaining independence from agricultural policy (e.g. increase in cross-compliance requirements, increase in requirements for livestock farming and plant based production)	push	3.41	1.70	13
Governmental support and subsidies (support for conversion/reutilization of farm buildings, rural development programs and projects)	pull	1.59	1.12	22
Tax reasons	pull	1.06	0.24	24
Average of all extrinsic motives		**3.09**	**0.62**	
Average of all push motives		3.11	0.40	
Average of all pull motives		3.33	0.42	

Note: The statements were measured on a Likert scale ranging from 1 to 5 (not important - very important). The minimum score of all suggested motives was 1 and the maximum score was 5.

To further illustrate the differences between motive categories Figure 4.2 shows boxplots of motive categories for agritourism farmers. The left panel shows box-plots of the average scores of each farm for each of the four categories. The right panel shows the average of motives for each farm if grouped into pull and push factors. We find that family and extrinsic motives are less important than farm-survival and intrinsic motives in our sample. Furthermore, we find on average the largest discrepancies, measured in standard deviations, with respect to the importance of intrinsic motives. Whereas the importance of farm-survival motives is more similar within our sample. Along these lines, we find that pull factors are more relevant for the agritourism decision in our sample. Furthermore, farmers could also add motives they did not find in the list but where relevant to them in the decision to start the agritourism venture. Many of the comments point towards economic reasons including the synergetic effect of the agritourism venture and existing direct sale on the farm. The statements comprised: i) “With the gastronomy (café) we hoped to be able to advertise the on farm blueberry sale to a larger customer base.”, ii) “We organize events, and public tours on the farm to attract more customers, and educate the public.”, iii) “We wanted to attract people to visit the farm and be able to sell the Christmas trees at higher prices.”

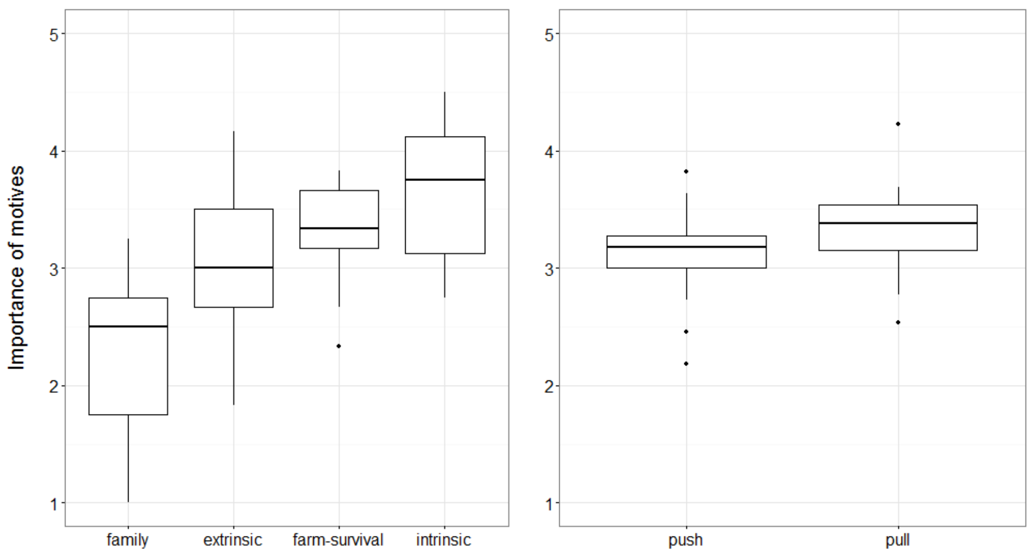


Figure 4.2: Differences in motive categories

Furthermore, open answers point towards the influence of the family situation on the motivation to start the agritourism venture: iv) “I was close to retirement and physically not capable to do the hard farm labor anymore. Agritourism gave us an opportunity to do less physical work and stay on the farm.", v) "Previously the house was used by the retired farming generation, after their passing the renovation was easily affordable due to the high demand." and vi) "Our daughter had a great interest in running an equestrian business."

4.4.2 Role of farmwomen in agritourism ventures

In order to examine the role of farmwomen in agritourism ventures we examined the agritourism activities each farm is involved in, separately. Table 4.2 presents the average involvement of farmwomen in initialization and realization of the agritourism venture. Four interviewed agritourism farmer stated not to have a spouse, hence they are excluded from the calculations presented in Table 4.2.

Table 4.2: Summary statistic of agritourism ventures by type and farmwomen participation

N = 13 (farms with agribusiness and spouse)		**farmwomen initialization**		**farmwomen realization**	
	sum	**mean**	**SD**	**mean**	**SD**
Accommodation	5	2.40	0.89	3.20	1.48
Organizing events	5	2.60	1.52	2.20	0.84
Gastronomy	5	3.00	1.58	2.60	1.14
Renting out locations	4	3.50	1.00	3.00	0.00
Equestrian business	3	2.33	1.15	3.00	1.73
Agritourism	13	2.96	1.11	3.00	1.22

Note: The involvement of farmwomen in initialization and realization of the agritourism venture was measured on a Likert scale ranging from 1 to 5 (farmwoman not involved - farmwoman mainly involved). The minimum score of involvement was 1 and the maximum score was 5.

We find that the initialization and realization of the agritourism venture is usually made jointly. Nevertheless, there are differences in involvement depending on the type of agritourism venture. For farmwomen, the highest involvement with initialization is for renting out location ventures, with realization the highest involvement of farmwomen is in accommodation ventures. Whereas the lowest involvement of farmwomen is in the realization of organizing events on the farm and the initialization of equestrian businesses.

4.4.3 Farm, farmer and household characteristics

In Table 4.3 we present a full list of variables included in our analysis. Furthermore, in Table 4.4 we present summary statistics of farm farmer and household characteristics for agritourism and non-agritourism farmers. Additionally we use the Mann-Whitney-Wilcoxon Test to interpret differences amongst the two groups. We find that on average agritourism farms are operated less frequently fulltime, furthermore they have significantly larger portfolios of on-farm diversification activities (including a total 14 possible on-farm diversification strategies). In our sample agritourism farms are significantly more often crop and fodder producing farms (where fodder production represents the major income source) with an average size between 30 and 40ha. Non-agritourism farms are more frequently horticulture and livestock farms, and on average significantly larger (60 - 70ha). In our sample, we find significantly more female farm operators on agritourism farms (N = 4) than on non-agritourism farms (N = 0). Furthermore, agritourism farm operators are compared to non-agritourism farmers on average older and hold significantly less frequently a university degree. Higher agricultural education (e.g. certified agriculturist or masters certificate in agriculture) is contrarily on average more likely within the group of agritourism farmers. We find high agricultural attachment in both groups, but find a slightly stronger attachment for agritourism farms. In all measures of risk preferences included in our analysis we find that agritourism farmer are more risk averse. More specifically we find that agritourism farmer are significantly more risk averse in the multiple price list with an agricultural decision frame and in the business statement with respect to marketing risks. On the farm household level we find that on average agritourism farms have less family workforce, are significantly less often married or in a long term relationship and less often a secured successor compared to the non-agritourism farms in our sample.

Table 4.3: Variable description

	Variable description
Farm	
Fulltime	1 if fulltime farming
Diversification portfolio	count of diversification activities (min 0 - max. 14) [a)]
Horticulture	main production focus on horticulture
Crop farming	main production focus on crop production
Fodder producing farms	main production focus on fodder production
Livestock farming	main production focus on livestock production
Size	For agricultural production utilized area 1 = up to 10 ha; 2 = 10 to 20 ha; 3 = 20 to 30 ha; 4 = 30 to 40 ha; 5 = 40 to 50 ha; 6 = 50 to 60 ha; 7 = 60 to 70 ha; 8 = 70 ha and above
Farmer	
Gender	1 if male
Age	years
Higher general education	1 if education at university level
Higher agricultural education	1 if certified agriculturist or masters certificate in agriculture
Attachment to agriculture	scale from 1 to 5, 1 = “very attached” to 5 = “no attachment”
Risk preferences (MPL)	count of safe lottery choices, 1 = very risk loving; 5= risk neutral; 9 = very risk averse
Risk preferences (self-assessment)	inverse scale from 0 to 10, 0 = “not at all willing to take risks” to 10 = “very willing to take risks” [b)]
Risk preferences (production)	scale from 1 to 5, 1 = fully agree; 5 = don’t agree [c)]
Risk preferences (marketing)	scale from 1 to 5, 1 = fully agree; 5 = don’t agree [c)]
Risk preferences (finances)	scale from 1 to 5, 1 = fully agree; 5 = don’t agree [c)]
Risk preferences (agriculture generally)	scale from 1 to 5, 1 = fully agree; 5 = don’t agree [c)]
Household	
Family workforce	number of family members working on the farm
Married	1 if married or in a long term relationship
Succession	1 = yes, succession secured; 0.5 = succession likely; 0 = succession not intended in the near future; 0.5 = succession unlikely; -1 = no succession secured

*Significant at the 10% level, ** Significant at the 5% level, *** significant at the 1% level

[a)] Including: direct marketing, processing of agricultural products, gastronomy, accommodation, equestrian business, renting out locations, events, Christmas trees, social farming, renewable wind energy, biogas production, photovoltaic systems, agricultural labor for others and woodwork.

[b)] We invert the original self-assessment scale of risk aversion to ease the interpretation. For all measures of risk aversion higher values now indicate higher risk aversion.
[c)] Agreement with the following four statements: I am willing to take more risks than my colleagues with respect to production. 2. I am willing to take more risks than my colleagues with respect to marketing. 3. I am willing to take more risks than my colleagues with respect to financial issues. 4. I am willing to take more risks than my colleagues with respect to agriculture generally.

Table 4.4: Summary statistics of farm farmer and household characteristics for agritourism and non-agritourism farms

	Agritourism farms N = 17		Non-agritourism farms N = 16		Mann-Whitney-Wilcoxon-Test
	mean	SD	mean	SD	p-value
Farm					
Fulltime	0.71	0.47	0.75	0.45	0.797
Diversification portfolio	2.88	1.41	1.69	0.60	0.007***
Horticulture	0.00	0.00	0.12	0.34	0.151
Crop farming	0.24	0.44	0.00	0.00	0.045**
Fodder producing farms	0.18	0.39	0.12	0.34	0.706
Livestock farming	0.35	0.49	0.50	0.52	0.412
Size	4.76	2.7	7.12	1.71	0.003***
Farmer					
Gender	0.82	0.39	1.00	0.00	0.089*
Age	52.82	12.57	46.81	13.77	0.387
Higher general education	0.19	0.4	0.56	0.51	0.033**
Higher agricultural education	0.50	0.52	0.31	0.48	0.298
Attachment to agriculture	1.35	0.49	1.44	0.73	1.000
Risk preferences (MPL)	5.88	1.83	4.69	1.82	0.089*
Risk preferences (self-assessment)	4.88	1.96	4.00	1.32	0.184
Risk preferences (production)	3.53	1.18	3.25	1.06	0.503
Risk preferences (marketing)	4.06	0.90	2.81	1.05	0.002***
Risk preferences (finances)	3.88	1.22	3.81	1.22	0.865
Risk preferences (agriculture generally)	3.65	1.32	3.31	0.95	0.343
Household					
Family workforce	1.71	0.94	1.91	0.93	0.594
Married	0.76	0.44	1.00	0.00	0.045**
Succession	0.26	0.69	0.38	0.56	0.747

4.5 Discussion and conclusion

This study uses interviews to examine determinants and motives underlying decisions by farmers in the German region of Muenster to start agritourism ventures.

We identify pull motives to be dominant in the decision making process of agritourism farmers in our sample. Farmers are mainly opportunity driven; they rate the motive to use market opportunities (e.g. high demand in the area, niche markets) on average highest. Thus, targeting extension and policies on market opportunities can be an efficient strategy to enhance the uptake of agritourism activities. When further categorizing the push/pull motives into economic, intrinsic, family and extrinsic motives we find that overall intrinsic motives are rated as strongest determinants to influence the diversification decision by agritourism farmers. Thus, the joy in working within the agritourism sector and the contact with people are crucial for starting an agritourism venture in our sample.

Our interviews revealed additional motives that are relevant. For instance, synergetic effects of agritourism on other on-farm diversification strategies as well as family issues have been identified as relevant. Many farms indicate that they use the agritourism venture as advertising tool to attract visitors for the on-farm sale activity. This is in line with other studies that find that agritourism ventures can have synergetic relationships with other non-agricultural farm-diversification enterprises (Barbieri, 2009, Haugen and Vik, 2008). These results of our analysis are particularly important for the here investigated farms that operate close to urban areas and thus can access large customer basis.

Even though family motives are on average rated least important in our survey (Table 4.1), farmers indicated in open parts of the interview that the motivation for agritourism is often connected to the farm family life cycle. For some farmers agritourism is an attractive alternative to decrease the physically hard work required in conventional agriculture. This is supported by findings from Ollenburg and Buckley (2007) who compare the motives of different types of agritourism farmers depending on their age, farm type (long-term family vs. lifestyle migrants) and occupation (full-time vs. part-time). They conclude that older full-time farmers scale down farm activities and shift resources to a less labor-intensive way to earn income. Thus, extension and policies could be specifically tailored to older farmer in order to enhance the uptake of agritourism activities.

The importance of the farm family structure is further revealed in our analysis when focusing on the involvement of farmwomen in the agritourism business. We find that the agritourism venture is often a joint project of the farming couple (see also Haugen and Vik, 2008, Phelan and Sharpley, 2011). However, the role of farmwomen depends on the activity. Farmwomen are more involved in activities traditionally performed by female household members (e.g. accommodation, gastronomy and renting out locations) and less in adventure activities (e.g. the organization of events) (Haugen and Vik, 2008). Furthermore, we find the initializing impulse to start an agritourism venture is more frequently coming from the male spouse, whereas the daily work is more often performed by the farmwomen.

Comparing objective characteristics of agritourism and non-agritourism farmers, we find that agritourism farmers have a larger portfolio of diversification activities. Thus, our results support the hypothesis that agritourism activities are more likely to have a portfolio of on-farm diversification activities as there are synergistic relationships between agritourism and other activities (see also Barbieri, 2009, Haugen and Vik, 2008). Moreover, our results show that less labor-intensive farming practices such as crop farming are associated with a larger diversification portfolio, compared to farming types with a constant high labor demand (e.g. livestock production). Similar to the conclusions presented by Vik and McElwee (2011) and Meraner et al. (2015), we find that the agricultural size of agritourism farms is significantly smaller than non-agritourism farms. Thus, we assume that farms in our sample have already shifted large parts of their resources towards agritourism. We find in our sample, a larger share of female main farm operators of agritourism farms. This is in line with the argument proposed by Brandth and Haugen (2007) that agritourism work is traditionally female and nonpaid work of farmwomen is capitalized in agritourism ventures. We find agritourism farmers to be on average older, supporting the hypothesis that agritourism is not something to start a very young age as starting capital requirements are high (see also Haugen and Vik, 2008). Answers to open questions confirm additionally findings by Benjamin and Kimhi (2006), agritourism ventures are increasingly attractive at a very late stage in the farmers life when low labor intensity of some agritourism ventures is determining the diversification decision. Non-agritourism farmer hold significantly more often a university degree. Whereas higher agricultural education is more common amongst agritourism farmers. Our results cannot confirm conclusions drawn by Barbieri (2009) and Haugen and Vik (2008) that higher agricultural education points towards a higher involvement of agritourism farmers with agriculture as both groups of farmers show similar high attachment with agriculture.

Finally, we investigated the role of risk preference for agritourism activities. The three different methods to elicit the farmers risk preferences included in our study all point towards more risk averse preferences in the group of agritourism farmers. More specifically, agritourism farmers are more risk averse with respect to agricultural investments (MPL) and marketing, indicating that investment and marketing risks are most severe for agritourism farmers. These results show that more risk averse producers allocate more resources to activities with less income volatility (McNamara and Weiss, 2005). Risk management support and extension may thus explicitly account for such diversification activities. Furthermore, expected increases in production or market risks, e.g. due to further liberalization of markets and due to climate change (e.g. Chavas, 2011, Olesen et al., 2011) can cause a larger uptake of diversification activities such as agritourism. On the household level, we find only significant differences for the marital status between the two groups agritourism and non-agritourism farms. Unlike other studies in the field we find that non-agritourism farmers are more often married or in a long-term relationship. Nevertheless, as pointed out previously for those farmers with a spouse the joint work at the farm is an important factor influencing the decision to start an agritourism venture.

The novel contribution of this study lies in the combination of the analysis of motives and objective farm and farmer characteristics, for the first time including experimental methods to elicit farmers risk preferences, underlying the diversification decision. This provides useful insights into the background of agritourism farmers. However, this research should be built upon when exploring the possible relationship of risk preferences and motives to start agritourism ventures on a larger scale. Furthermore, additional research should focus on the role of all family members in different stages of the farm diversification businesses. In this line of argument, next to farmwomen the role of successors or other family members living on the farm should be explored further. The results of this analysis can be useful for policy makers wishing to exploit the motives and characteristics that trigger farmers to start agritourism ventures outside conventional agriculture.

4.6 References

Bagi, Faqir S., and Richard J. Reeder. 2012. "Factors affecting farmer participation in agritourism." *Agricultural and Resource Economics Review* 41 (2):189.

Barbieri, Carla. 2009. "A comparison of agritourism and other farm entrepreneurs: Implications for future tourism and sociological research on agritourism." Northeastern Recreation Research Symposium, Bolton Landing, NY, USA, March 2008.

Barrett, Christopher, Thomas A. Reardon, and Patrick M. Webb. 2001. "Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications." *Food Policy* 26 (4):315-331.

Benjamin, Catherine, and Ayal Kimhi. 2006. "Farm work, off-farm work, and hired farm labour: estimating a discrete-choice model of French farm couples' labour decisions." *European Review of Agricultural Economics* 33 (2):149-171.

Brandth, Berit, and Marit S. Haugen. 2007. "Gendered work in family farm tourism." *Journal of Comparative Family Studies* 38 (3):379-393.

Busby, Graham, and Samantha Rendle. 2000. "The transition from tourism on farms to farm tourism." *Tourism Management* 21 (6):635-642.

Chavas, Jean-Paul. 2011. "Agricultural policy in an uncertain world." *European Review of Agricultural Economics* 38 (3):383-407.

Crosetto, Paolo, and Antonio Filippin. 2015. "A theoretical and experimental appraisal of four risk elicitation methods." *Experimental Economics* 19 (3):1–29.

Di Domenico, Maria Laura, and Graham Miller. 2012. "Farming and tourism enterprise: Experiential authenticity in the diversification of independent small-scale family farming." *Tourism Management* 33 (2):285-294.

European Commission. 1990. *Community Action to Promote Rural Tourism - Communication from the Commission*.

European Parliamentary Research Service. 2016. *Farm diversification in the EU*. European Parliament: Briefing.

Evans, Nicholas J., and Brian W. Ilbery. 1989. "A conceptual framework for investigating farm-based accommodation and tourism in Britain." *Journal of Rural Studies* 5 (3):257-266.

Hansson, Helena, Richard Ferguson, Christer Olofsson, and Leena Rantamäki-Lahtinen. 2013. "Farmers' motives for diversifying their farm business – The influence of family." *Journal of Rural Studies* 32:240-250.

Hardaker, Brian J., Ruud B. M. Huirne, Jock R. Anderson, and Gudbrand Lien. 2004. *Coping with risk in agriculture*. 2 ed. Wallingford UK, Cambridge USA: CABI publishing.

Haugen, Marit S., and Jostein Vik. 2008. "Farmers as entrepreneurs: the case of farm-based tourism." *International Journal of Entrepreneurship and Small Business* 6 (3):321-336.

Hellerstein, Daniel, Nathaniel Higgins, and John Horowitz. 2013. "The predictive power of risk preference measures for farming decisions." *European Review of Agricultural Economics* 40 (5):807–833.

Hjalager, Anne-Mette. 1996. "Agricultural diversification into tourism: Evidence of a European community development programme." *Tourism Management* 17 (2):103-111.

Holt, Charles A., and Susan K. Laury. 2002. "Risk aversion and incentive effects." *American Economic Review* 92 (5):1644–1655.

Ilbery, Brian W. 1991. "Farm diversification as an adjustment strategy on the urban fringe of the West Midlands." *Journal of Rural Studies* 7 (3):207–218.

Ilbery, Brian W., and Ian Bowler. 1998. *From agricultural productivism to post-productivism*. London UK: Longman Ltd.

Ilbery, Brian W., Ian Bowler, Gordon Clark, Alastair Crockett, and Alastair Shaw. 1998. "Farmbased tourism as an alternative farm enterprise: A case study from the northern Pennines, England." *Regional Studies* 32 (4):355–365.

King, Nigel, and Christine Horrocks. 2010. *Interviews in qualitative research*. London UK: Sage.

Kostov, Philip, and John Lingard. 2003. "Risk management: a general framework for rural development." *Journal of Rural Studies* 19 (4):463-476.

Lange, Andrej, Annette Piorr, Rosemarie Siebert, and Ingo Zasada. 2013. "Spatial differentiation of farm diversification: How rural attractiveness and vicinity to cities determine farm households' response to the CAP." *Land Use Policy* 31:136–144.

Le Grand, Lodewijk, and Martine van Meekeren. 2008. *Urban–rural relations: Dutch experiences of the LEADER+ network and rural innovation in areas under strong urban influences*. Network for Rural Areas: Rurality near the city.

Lehner-Hilmer, Anita. 1999. *Einstellungen der Landwirte zu selbständigen Erwerbskombinationen: Auswirkungen auf den Strukturwandel in der Landwirtschaft*, *Schriftenreihe agrarwissenschaftliche Forschungsergebnisse*. Hamburg GER: Kovač.

Maart-Noelck, Syster C., and Oliver Musshoff. 2013. "Measuring the risk attitude of decision-makers: are there differences between groups of methods and persons?" *Australian Journal of Agricultural and Resource Economics* 58 (3):336–352.

McElwee, Gerard. 2008. "A taxonomy of entrepreneurial farmers." *International Journal of Entrepreneurship and Small Business* 6 (3):465-478.

McGehee, Nancy G., and Kyungmi Kim. 2004. "Motivation for agri-tourism entrepreneurship." *Journal of Travel Research* 43 (2):161–170.

McGehee, Nancy G., Kyungmi Kim, and Gayle R. Jennings. 2007. "Gender and motivation for agri-tourism entrepreneurship." *Tourism Management* 28 (1):280–289.

McInerney, John P., and Martin Turner. 1991. *Patterns, performance and prospects in farm diversification*. Exeter UK: University of Exeter Agricultural Economics Unit.

McNally, Sandra. 2001. "Farm diversification in England and Wales — what can we learn from the farm business survey?" *Journal of Rural Studies* 17 (2):247-257.

McNamara, Kevin T., and Christoph Weiss. 2005. "Farm Household Income and On- and Off-Farm Diversification." *Journal of Agricultural and Applied Economics* 37 (1):37-48.

Medhurst, Alison, and Robin Segrave. 2007. *Why Do Farming Families Diversify?* Australian Government: Rural Industries Research and Development Corporation 07, 156.

Menapace, Luisa, Gregory Colson, and Roberta Raffaelli. 2013. "Risk aversion, subjective beliefs, and farmer risk management strategies." *American Journal of Agricultural Economics* 95 (2):384–389.

Menapace, Luisa, Gregory Colson, and Roberta Raffaelli. 2015. "A comparison of hypothetical risk attitude elicitation instruments for explaining farmer crop insurance purchases." *European Review of Agricultural Economics* 43 (1):113-135.

Meraner, Manuela, Wim Heijman, Tom Kuhlman, and Robert Finger. 2015. "Determinants of farm diversification in the Netherlands." *Land Use Policy* 42:767-780.

Meuwissen, Miranda P. M., Rudd B. M. Huirne, and Brian J. Hardaker. 2001. "Risk and risk management: an empirical analysis of Dutch livestock farmers." *Livestock Production Science* 69 (1):43–53.

Mishra, Ashok K., Hisham S. El-Osta, and Carmen L. Sandretto. 2004. "Factors affecting farm enterprise diversification." *Agricultural Finance Review* 64 (2):151-166.

Nickerson, Norma, Rita J. Black, and Stephen F. McCool. 2001. "Agritourism: motivations behind farm/ranch business diversification." *Journal of Travel Research* 40 (1):19–26.

Nilsson, Per Åke 2002. "Staying on farms: An Ideological Background." *Annals of Tourism Research* 29 (1):7-24.

Olesen, Jørgen E., Miroslav Trnka, Kurt Kersebaum, C., Arne O. Skjelvåg, Bernard Seguin, Pirjo Peltonen-Sainio, Federica Rossi, Jerzy Kozyra, and Fabio Micale. 2011. "Impacts and adaptation of European crop production systems to climate change." *European Journal of Agronomy* 34 (2):96-112.

Ollenburg, Claudia, and Ralf Buckley. 2007. "Stated economic and social motivations of farm tourism operators." *Journal of Travel Research* 45 (4):444-452.

Oppermann, Martin. 1996. "Rural tourism in Southern Germany." *Annals of Tourism Research* 23 (1):86–102.

Oppermann, Martin. 1997. "Rural tourism in Germany: Farm and rural tourism operators." In *The business of rural tourism: International perspectives*, edited by Stephen Page and Donald Getz, 108-119. London UK, Bonn GER, Boston USA: International Thomson Business Press.

Pfeifer, Catherine, Roel A. Jongeneel, Marthijn P. W. Sonneveld, and Jetse J. Stoorvogel. 2009. "Landscape properties as drivers for farm diversification: A Dutch case study." *Land Use Policy* 26 (4):1106–1115.

Phelan, Chris, and Richard Sharpley. 2011. "Exploring Agritourism Entrepreneurship in the UK." *Tourism Planning & Development* 8 (2):121-136.

R Core Team. 2016. "R: A language and environment for statistical computing." http://www.R-project.org/.

Reynaud, Arnaud, and Stéphane Couture. 2012. "Stability of risk preference measures: results from a field experiment on French farmers." *Theory and Decision* 73 (2):203–221.

Segal, Gerry, Dan Borgia, and Jerry Schoenfeld. 2005. "The motivation to become an entrepreneur." *International Journal of Entrepreneurial Behavior & Research* 11 (1):42-57.

Sharpley, Richard, and Adrian Vass. 2006. "Tourism, farming and diversification: An attitudinal study." *Tourism Management* 27 (5):1040–1052.

van Winsen, Frankwin, Yann de Mey, Ludwig Lauwers, Steven van Passel, Mark Vancauteren, and Erwin Wauters. 2014. "Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies." *Journal of Risk Research* 19 (1):56-78.

Vik, Jostein, and Gerard McElwee. 2011. "Diversification and the entrepreneurial motivations of farmers in Norway." *Journal of Small Business Management* 49:390–410.

Walford, Nigel. 2001. "Patterns of development in tourist accommodation enterprises on farms in England and Wales." *Applied Geography* 21 (4):331-345.

Weaver, David B., and David A. Fennell. 1997. "The vacation farm sector in Saskatchewan: a profile of operations." *Tourism Management* 18 (6):357-365.

4.7 Appendix 4.A

	A	B	A	B
1	10% probability of a 100.000 € return and 90% probability of a 80.000 € return	10% probability of a 192.500 € return and 90% probability of a 5.000 € return	☐	☐
2	20% probability of a 100.000 € return and 80% probability of a 80.000 € return	20% probability of a 192.500 € return and 80% probability of a 5.000 € return	☐	☐
3	30% probability of a 100.000 € return and 70% probability of a 80.000 € return	30% probability of a 192.500 € return and 70% probability of a 5.000 € return	☐	☐
4	40% probability of a 100.000 € return and 60% probability of a 80.000 € return	40% probability of a 192.500 € return and 60% probability of a 5.000 € return	☐	☐
5	50% probability of a 100.000 € return and 50% probability of a 80.000 € return	50% probability of a 192.500 € return and 50% probability of a 5.000 € return	☐	☐
6	60% probability of a 100.000 € return and 40% probability of a 80.000 € return	60% probability of a 192.500 € return and 40% probability of a 5.000 € return	☐	☐
7	30% probability of a 100.000 € return and 70% probability of a 80.000 € return	70% probability of a 192.500 € return and 30% probability of a 5.000 € return	☐	☐
8	20% probability of a 100.000 € return and 80% probability of a 80.000 € return	80% probability of a 192.500 € return and 20% probability of a 5.000 € return	☐	☐
9	10% probability of a 100.000 € return and 90% probability of a 80.000 € return	90% probability of a 192.500 € return and 10% probability of a 5.000 € return	☐	☐
10	100% probability of a 100.000 € return and 90% probability of a 80.000 € return	100% probability of a 192.500 € return and 0% probability of a 5.000 € return	☐	☐

Figure 4.A.1: Multiple price list (MPL) with agricultural frame

The exact wording of the preceding question is translated from German as following: "Assume that you are offered to make an agricultural investment. Here you will get with different associated probabilities for investment A a return of 100.000 € or 80.000 € and for investment B a return of 192.500 € or 5.000 €. You can choose in the following table in each row between the two investment options (A or B)."

Furthermore, farmers where informed that real payouts are scaled down by 1.000€. Risk preferences are indicated by the sum of safe choices made. In the last row clearly choice B is dominating choice A, thus this question is merely a control question, testing the subjects understanding of the task.

Chapter 5

Diversification in peri-urban agriculture: a case study in the Ruhr metropolitan region*

* Meraner, M., B. Pölling and R. Finger (currently under review)

Abstract

This article identifies determinants of the uptake and intensity of farm diversification in the peri-urban Ruhr metropolitan region in Germany. Our analysis uses a unique combination of risk perception and preferences with elements of the farms' geographical environment obtained from surveys and geodata. A double hurdle model is used to analyze the diversification decision and the decision on diversification intensity among farmers that have decided to diversify. We find that high perception of market and price risks as well as farmers' past experiences increases the farmer's probability to seek income stabilizing on-farm non-agricultural diversification.

Keywords: on-farm non-agricultural diversification, decision making, peri-urban agriculture

JEL classification: Q12

5.1 Introduction

The importance of farm diversification to stabilize farm incomes and income risk has rapidly grown over the last years (European Parliamentary Research Service, 2016, McNamara and Weiss, 2005). The uptake of diversification activities is particularly large in farming systems in urban and peri-urban areas because the proximity to large agglomerations influences the demand for agricultural goods and services as well as the opportunity costs of farming activities. More specifically, proximity to urban centers increases incentives to develop new activities and valorizes the multifunctional nature of agriculture due to increased demand, short supply chains, direct marketing opportunities and community supported agriculture (Ilbery, 1991, Wilson, 2008, Heimlich and Barnard, 1992). Contrarily the increased demand for land and labor created by high population density generates high opportunity costs as well as increased public control (Monaco et al., 2017). Furthermore, farm diversification in peri-urban areas is considered essential from a societal point of view for the maintenance of landscapes, the socio-economic viability of a region and ecological functions, as well as environmentally sustainable forms of the provision of food and other ecosystem services (Zasada, 2011, Heimlich and Barnard, 1992, Clark, Munroe, and Mansfield, 2010). Thus, decisions made by farmers in urban and peri-urban areas are of utmost importance for consumers, inhabitants of urban areas and policymakers (McClintock, 2010). More specifically, a better understanding of drivers of farmers' behavior enables designing more efficient policies supporting intended farm diversification processes. In addition, revealing the processes and driving forces of farm diversification and development allows an incorporation of agriculture in models of socio-spatial relationships in food systems in urban and peri-urban areas.

Different terms are used for commercial farming activities in and near cities or wider agglomerations. Parallel to the global urban gardening movement with predominantly social goals, commercial farming close to cities and regional urban food systems are research topics of increasing interest (Ernwein, 2014). The definition of the often synonymously used terms ‘urban farming’, ‘urban agriculture’, ‘urban agro-food systems’, ‘metropolitan agriculture’, ‘urban fringe agriculture’, and ‘peri-urban agriculture’ is heterogeneous in related research. We follow Opitz et al. (2016) and define ‘peri-urban agriculture’ as ‘small- to large-scale agriculture that cultivates agricultural land predominantly at the fringes of cities’ (p. 353) (see also Ernwein, 2014). Thus, peri-urban agriculture embraces all commercial farming activities within cities or wider metropolitan areas.

Farm diversification is often characterized by a combination of multiple diversification activities (Meraner et al., 2015, Haugen and Vik, 2008, Carter, 1998). In the peri-urban context, specifically diversification activities on the farm that are not related to core agricultural activities (i.e. on-farm non-agricultural diversification activities), such as agritourism activities, the provision of services, equestrian businesses, as well as on-farm processing and direct sales activities, are of particular importance (Ilbery, 1991, Zasada, 2011).

Earlier research has identified the geographical environment, farm and farmer characteristics as well as the individual frame of decision-making reference to influence the diversification decision (Mishra, Hisham, and Carmen, 2004, McNamara and Weiss, 2005, Barnes et al., 2015). In particular, existing research shows that the farmer's decision making under uncertainty is based on the farmer's individual frame of reference i.e. her/his own reality that is based on past experiences, the subjective perception of risks and risk preferences (Slovic, Fischhoff, and Lichtenstein, 1982, Menapace, Colson, and Raffaelli, 2013, van Winsen et al., 2014).

This paper fills gaps in the literature in different dimensions. First, we expand the dichotomous focus on diversification decisions of farms, but also investigate the intensity of diversification in a peri-urban setting. Second, this study is the first to include farmers' past experiences, risk perception and risk preferences directly elicited from the decision makers to explain diversification choices. Third, we present a unique combination of socio-economic and geographical determinants of farm diversification. Our empirical analysis addresses the 'Ruhr Metropolis', Germany's largest polycentric agglomeration that consists of 53 municipalities[38].

The remainder of the paper is structured as follows. The next section presents a conceptual model of farm diversification that is the basis for our empirical analysis. This is followed by a description of the data collection and case study area, including a description of all variables used. The fourth section introduces the empirical approach

[38] This survey has been subject of an earlier paper (Pölling et al. submitted) which the here presented analysis extends in two ways. First, we focus on the farmer's diversification decision and diversification intensity in the peri-urban context as a risk management strategy. Thus, we include possible farm adaptation strategies to the city (i.e. intensive horticulture production) as factors influencing the diversification decision. Second, we include a wider set of factors influencing the diversification decision, specifically focusing on the farmers decision frame, geographical characteristics, farm and personal characteristics.

and the fifth section reports the estimation results. The concluding remarks and discussion are presented in the final section.

5.2 Conceptual model and theoretical background

We consider farms as diversified if farm resources (land, labor or capital) are used for activities other than production of conventional crops and livestock to generate income. Thus, this also includes activities related to vertical integration (i.e. further processing and on-farm marketing and retailing of agricultural products) (Ilbery, 1991, McNally, 2001, Barnes et al., 2015, Weltin et al., 2017), which is also referred to as on-farm non-agricultural diversification. More specifically, this includes agritourism activities (gastronomy, accommodation, renting out facilities and recreational activities), the provision of services (social services, land or forest services), equestrian businesses, energy production (solar, wind or biogas energy production), processing (plant products or animal products) and direct sales activities (on-farm shop, delivery service, market stand, street stand, vending machine and party-service). The alternative strategy to “diversification” is in the following called “no diversification”, i.e. specializing in one activity rather than diversifying. Specialization can go hand in hand with expansion of the farm business, but can also be a ‘business as usual’ strategy.

The extent to which resources are allocated to the non-agricultural income activities is in many studies conceptually based on a farm household model of optimal labor allocation. Built on an expected utility framework, rationally acting farm households, are assumed to maximize their utility over consumption and leisure time subject to time and budget constraints (Meyer, 2002, Weltin et al., 2017). However, the expected utility framework has been criticized as it fails to describe observed behavior (Menapace, Colson, and Raffaelli, 2013, Kahneman and Tversky, 1979, van Raaij, 1981). Hence there is a need to extend the traditional expected utility framework of economic decision making to include intrinsic perceptions, attitude and value settings (Slovic, Fischhoff, and Lichtenstein, 1982, van Raaij, 1981). Slovic, Fischhoff, and Lichtenstein (1982) refer to the above as the individual's frame of reference. In order to understand the decision maker's economic behavior, an understanding of her or his frame of reference is required because the decision maker's perceptual world forms the basis for her or his choices. Figure 5.1 shows the theoretical framework adapted from van Raaij (1981).

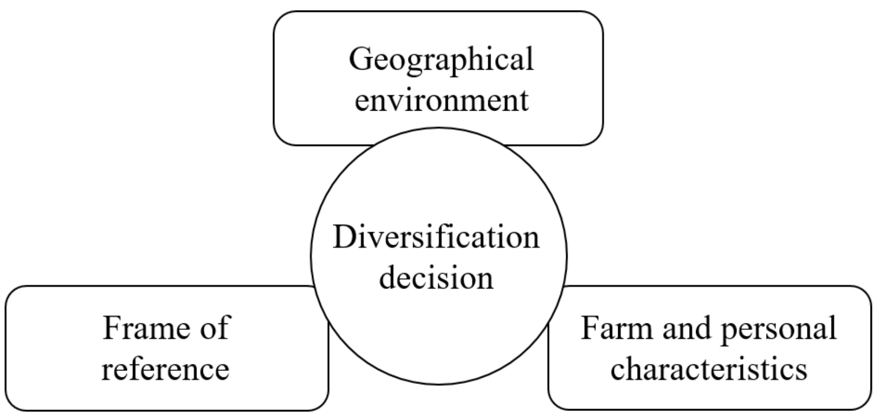


Figure 5.1: Determinants influencing farmer's diversification decision adapted from van Raaij (1981)

5.2.1 Diversification determinants

Several studies on on-farm diversification have shown the importance of the geographical environment on the economic decision making in the peri-urban context.

Peri-urban areas are characterized by land fragmentation, high competition for land by non-agricultural actors (Lovell, 2010, Pölling, Mergenthaler, and Lorleberg, 2016). These factors hamper cost-efficient expansions in terms of land and livestock units, and thus limit the possible developments in core agricultural activities (Lovell, 2010, Zasada, 2011, Mok et al., 2014, Heimlich and Barnard, 1992). Proximity to urban centers also goes alongside proximity to huge consumer markets promoting city-oriented adjustments of farms in production, marketing, and service provision. Herein, diversification is one key strategy farms situated in urbanized areas use to profit from the nearby city and to evade urban pressures on primary production (Wilson, 2008, Jarosz, 2008, Zasada et al., 2011, Monaco et al., 2017). Furthermore, soil quality is associated with the farmer's cropping decision and overall profitability. Farms located on less productive soils have lower yield potentials and are exposed to a higher farming risk and more volatile yields. Consequently, they are assumed to look for additional income outside the main farming activity (Meraner et al., 2015, Lange et al., 2013).

Observable farm and personal characteristics associated with on-farm non-agricultural diversification include the farm manager's occupation, farm type, size, the farm manager's age, education, available family workforce and succession. On-farm diversification is often referred to as farm survival strategy presenting an opportunity for farmers that want to stay *full-time* on the farm to earn extra income (Haugen and Vik, 2008, McNally, 2001). A very common finding in the literature is that *farm size* has a significant effect on the diversification decision. McNally (2001) and McNamara and Weiss (2005) suggest that larger farms (as measured in terms of average net income and number of livestock units) are more likely to be diversified, since they can allocate and exploit available resources more efficiently. Contrarily, Mishra, Hisham, and Carmen (2004) point out that larger farms (measured in terms of hectares of land) profit from economies of scale, making a specialization strategy more likely, reducing the uptake of diversification strategies. Furthermore, several researchers found that the *farm type* (i.e. the production focus) influences the farmer's diversification decision. Aubry and Kebir (2013) and Zasada et al. (2011) argue that horticultural and permanent crop farms (i.e. high value crop farms) are fragile when being dependent from global markets' long chains and are consequentially more likely to engage in on-farm non-agricultural diversification. Furthermore, Meraner et al. (2015) and Haugen and Vik (2008) find a larger probability of *high value crop farmer* to engage in a portfolio of on-farm non-agricultural diversification activities, exploiting the synergetic effects between on-farm sale and agritourism activities like gastronomy. Contrarily, farms engaging in *intensive livestock* production are less likely to engage in on-farm non-agricultural diversification activities due to external effects (e.g. odor nuisance) (Zasada et al., 2011). Furthermore, the farmer's *age* has been found to influence the diversification decision. Younger farmers often seek to strengthen the farm business viability by shifting excess labor, land and capital to on-farm diversification ventures (Barbieri and Mahoney, 2009, McNamara and Weiss, 2005). Several empirical studies reveal that a high *education* level of the main farm operator is positively associated with higher income from non-agricultural professions, including on-farm diversification activities requiring further training (McNamara and Weiss, 2005, Benjamin and Kimhi, 2006). *Succession* of the agricultural holding is the main mechanism of farm continuity for a family run farm business. According to the farm family life cycle theory, Potter and Lobley (1996) and Dries, Pascucci, and Gardebroek (2012) show that on-farm diversification is more likely to be perused when a successor is present as consequentially creating a stronger need for additional income to support the next generation's family. Furthermore, the *household size* is an indicator of on-farm labor availability, and an attribute that affects farm diversification. Meraner et al. (2015) and Mishra, Hisham, and Carmen (2004) suggest that farms with excess family labor capacities are more likely to create on-farm employment opportunities to use them efficiently.

Besides observable characteristics and the geographical farm environment the farmer's decision making depends on the personal frame of reference. This includes the perception of risks as well as past experiences and risk preferences. The subjective *risk perception* of different risk sources is determined by the objective risk the decision maker is exposed to and the subjective interpretation of risks. Consequentially, risk perception is the combination of the probability of the occurrence of an uncertain event and the consequential negative impact (Slovic, Fischhoff, and Lichtenstein, 1982). Assefa, Meuwissen, and Oude Lansink (2016) and van Winsen et al. (2014) find evidence that farmers who perceive risks to be very severe use long term survival strategies such as diversification to cope with risky production, market, institutional and labor market environments. Additionally, experienced *past losses* shape the farmer's personal frame of reference (e.g. Tversky and Kahneman, 1973). Farmers that experienced large losses in the past are assumed to avoid future risks and consequentially reallocate farm resources to less risky activities (Menapace, Colson, and Raffaelli, 2013). Earlier research on motives behind on-farm diversification found that the main driver for on-farm non-agricultural diversification is the reduction of risks associated with agricultural production (Barbieri and Mahoney, 2009, Hansson et al., 2013). Within this tradition, r*isk aversion* is generally associated with greater willingness to adopt risk reducing strategies i.e. probability to diversify (van Winsen et al., 2014). However, there is evidence that very risk averse farmers choose to shift the agricultural risk to third parties (e.g. insurance) over on-farm diversification (McNamara and Weiss, 2005, Meuwissen, Huirne, and Hardaker, 2001). Especially in peri-urban regions, off-farm opportunities are assumed to be an attractive alternative for risk averse farmers.

5.3 Data and case study area

5.3.1 Case study area

The conducted analysis covers farms located in Germany's largest polycentric agglomeration 'Ruhr Metropolis'. The Ruhr metropolitan area covers 53 municipalities with in total more than five million inhabitants. The average population density is above 1100 inhabitants / km². The core zone of the Ruhr metropolitan area is very densely populated and dominated by build-up areas for settlements, industries, and infrastructure, while the land use pattern becomes more heterogeneous outside of the core zone and comprises larger shares of green areas. One third of Ruhr metropolitan area is used for farming, which is high compared to other agglomerations of the global North (Pölling, Mergenthaler, and Lorleberg, 2016). Farmland losses are more pronounced where farmland is scarcest, so that most of the 500 ha which are on average annually transformed into other land uses than agriculture are located in the densely populated central. Like in monocentric cities, agricultural importance successively increases outwards towards the peri-urban city fringe building the transition zone to more rurally characterized areas. However, farmland is contained even in the Ruhr Metropolis' core zone due to the polycentric land use pattern. Green corridors situated between the cities' centers are often dominated by agricultural land uses, although continuous urban encroachments reduce land resources for farming steadily. Figure 5.2 illustrates the case study area[39].

[39] Furthermore, the location of 132 surveyed farms is depicted. For 24 surveyed farmers no match with the farms exact location was possible.

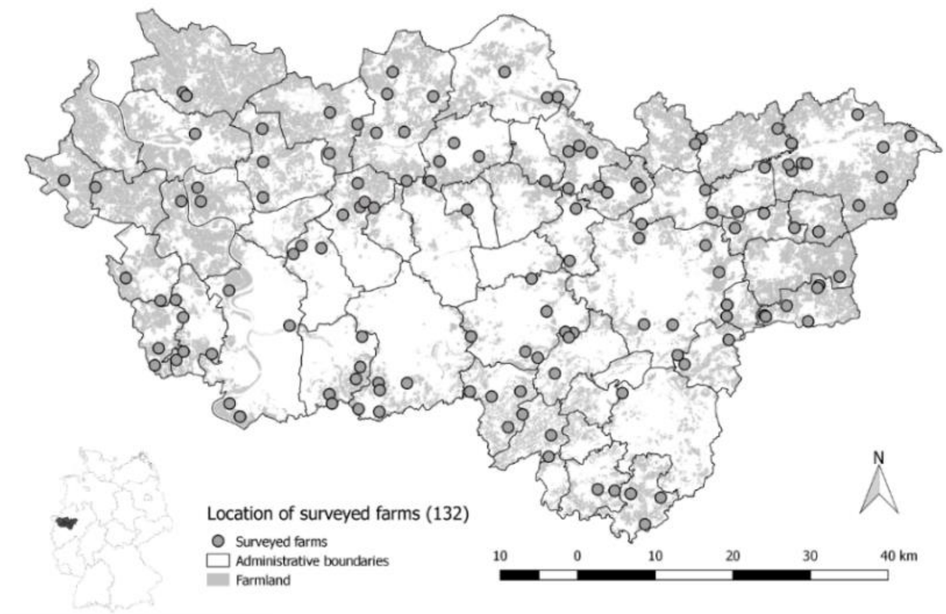


Figure 5.2: Map of the Ruhr metropolitan area and the location of 132 surveyed farms

5.3.2 Data and data collection

Primary data were collected from farm managers via a self-administered web survey in spring 2016. We addressed the farm managers in the Ruhr metropolitan area via the regional chamber of agriculture. We contacted all 2368 farm managers registered with the chamber of agriculture which relates to 70% of the total farm population in the area (IT.NRW, 2011). Before launching the web survey, we conducted 17 pre-tests with farmers and agricultural students. The first invitation to participate was sent via e-mail in the first week of March 2016; followed by a reminder two weeks later. The overall response rate was 14%, half of all respondents fully completed the survey, leading to a sample size of 156 farmers. The survey included following parts: (1) general information on the farm (full- or part-time farming, farm type, size, and diversification activities), (2) information on the farmer's risk perception, past losses and risk preferences, (3) personal demographic information on the farmer and household (age, level of education, succession, household size). Additionally, publicly available geo data was added to the web survey's primary database. This enabled us to connect the survey information with data on soil fertility, and distance to urban centers in 132 cases, i.e. farms.

Farmers risk perception is measured with two sets of questions related to four main risk sources farmers are exposed to. Based on literature research as well as expert interviews, we included market and price risks, production risks, institutional risks and labor risks (Meuwissen, Huirne, and Hardaker, 2001, van Winsen et al., 2014). Farmers were asked to indicate the importance of each source of risk as well as the severity of the possible impact caused by the risk source using five point Likert scales respectively (1 = "unimportant" to 5 = "very important" and 1 = "no impact" to 5 = "severe impact"). Risk perception scores are calculated as an average over the probability of the occurrence of an uncertain event and the consequential negative impact (Slovic, Fischhoff, and Lichtenstein, 1982). Additionally, we asked farmers to indicate whether they faced severe losses on the farm due to market, production or institutional risks over the last five years. We consider two relatively simple, easy to implement risk preference elicitation instruments and test their power in pertaining to actual farmer's diversification decisions by including. First, we use a general self-assessment (SA) of risk preferences on an 11 point Likert scale (Dohmen et al., 2011). However, risk attitudes are often assumed to differ over domains, i.e. decision makers can be simultaneously risk seeking and risk averse in different domains (Dohmen et al., 2011). Second, we thus use a set of four agriculture specific business statements (BS) to elicit domain specific risk preferences. The business statements measure attitude towards risk (i.e. market risk, production risk, institutional risk and agriculture risk in general) relative to other farmers, thus we use the term relative risk attitude in the remainder of this paper (Meuwissen, Huirne, and Hardaker, 2001, van Winsen et al., 2014). A detailed description of all variables included can be found in Table 5.1.

In the further analysis the probability to diversify and the diversification intensity are explanatory variables in a two-step decision process. In the first part of the analysis the dependent variable is defined as a binomial choice between diversification and no diversification. Within our sample, 79% of all farms engage in an on-farm non-agricultural diversification activity, which is a higher share than in the total population of all Ruhr farms[40]. Generally, the sample's high share of diversified farms is in line with other studies in European peri-urban areas (see e.g. Zasada et al., 2011). For the second part of the analysis, the intensity of diversification is measured as the number of on-farm non-agricultural diversification activities the farm business is engaged in. Farmers could choose from a set of 21 different diversification activities[41]. Intensity of

[40] Within the Ruhr metropolitan area participation in on-farm non-agricultural diversification varies on municipality level between 30 to nearly 70% of all farms with a tendency to higher shares towards the metropolitan's centre (IT.NRW, 2011). The high share of diversified farms in the sample is assumed to be linked to the intermediary point of access i.e. the chamber of agriculture. About 70% of all farms in the region are registered in their data base, originating from the EU CAP payment applications.

[41] The included diversification activities are: agritourism activities (gastronomy, accommodation, renting out facilities, recreational activities, other) social services, land or forest services, other services, equestrian business, renewable energy production, biogas production, other energy production, on-farm processing (plant products, animal products),

farm diversification ranges in the sample from 1 (28% of all diversified farms) to 8 (1% of all diversified farms) diversification activities.

On average, farms in our sample are located 7 km away from the closest city with more than 100,000 inhabitants. We find that diversified farms are located on average closer to urban hubs than non-diversified farms, a finding in line with findings of other research in the field (see e.g. Zasada, 2011). The sample's mean soil fertility, as measured in ground points, of 56.1 is slightly above the metropolitan's mean of 51.3 (Bodenschätzungsgesetz - BodSchätzG, 2007). Farms exploiting on-farm non-agricultural diversification are larger (on average 60 ha) farmland than their non-diversified counterpart (on average 41 ha). The sample's share of full-time farms (54%) and average farm size (55 ha) both suitably represent the region's Agricultural Census data of 52% and 48 ha respectively. Moreover, the share of high value crop farms in our sample (13%) as well as the share of intensive livestock farms (27%) is in line with Agricultural Census data (IT.NRW, 2011) (see Table 5.2). While 60% of the diversified farms are full-time farms, this ratio reaches only about one third for the non-diversified farms. Furthermore, the Agricultural Census 2010 reveals that two thirds of the farms in the region are run by farm managers older than 45 years. This is in line with our sample, in which the diversified farm managers are slightly younger (49 years) than the non-diversified farm managers (54 years).

Farmers in our sample perceive institutional risks to be most severe. This perception is on average higher within the group of non-diversified farmers compared

direct marketing (on-farm shop, delivery service, market stand, street stand, vending machine, party-service, other).

to their diversified colleagues. On average, 50% of all surveyed farmer suffered from severe losses due to market risks (e.g. volatile input and output prices) in the last five years. Furthermore, we find that farmers in our sample are on average risk averse (for both risk elicitation approaches), which is in line with previous findings, e.g. by Meuwissen, Huirne, and Hardaker (2001) and Menapace, Colson, and Raffaelli (2013). Farmers without an on-farm non-agricultural diversification strategy are on average more risk averse than farmers engaging in diversification.

Table 5.1: Description of explanatory variables

Variable	Description
DistUrb	Distance in kilometers between farm and outward boundary of densely built-up urban areas (i.e. city > 100,000 inhabitants)
SoilQual	Soil quality (0 = very poor fertility and 100 = very good fertility)[42]
Size	ha of cultivated land
HighVCrops	1 if high value crops producing farm
IntLivestock	1 if intensive livestock farm
Full-time	1 if full-time farmer
Age	Years
Educ	Highest degree of education in the German schooling system (1-9)[43]
Succession	1 if succession is sure, 0.5 if succession is 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, -2 if farm exit is planned
HHS	Number of household members
PercMarkRisk	Perceived probability of occurrence (1 = “not likely”, 5 = “very likely”) multiplied by perceived impact on 1 to 5 scale (1 = “no impact”, 5 = “very strong impact”) of market and price risks
PercInstRisk	Perceived probability of occurrence (1 = “not likely”, 5 = “very likely”) multiplied by perceived impact on 1 to 5 scale (1 = “no impact”, 5 = “very strong impact”) of institutional risks
PercProdRisk	Perceived probability of occurrence (1 = “not likely”, 5 = “very likely”) multiplied by perceived impact on 1 to 5 scale (1 = “no impact”, 5 = “very strong impact”) of production risks
PercLabRisk	Perceived probability of occurrence (1 = “not likely”, 5 = “very likely”) multiplied by perceived impact on 1 to 5 scale (1 = “no impact”, 5 = “very strong impact”) of labor risks
LossMarkRisk	1 if farm business suffered from severe losses in the past five years due to market risks
LossProdRisk	1 if farm business suffered from severe losses in the past five years due to production risks
LossInstRisk	1 if farm business suffered from severe losses in the past five years due to institutional risks
RA	General risk preferences on scale from 0 (= willing to take risks) to 10 (= very unwilling to take risks)
	Willingness to take more risks than my colleagues with respect to
RAAgric	…agriculture in general, on scale from 1 = agree, 5 = don't agree.
RAMark	…market and pricing, on scale from 1 = agree, 5 = don't agree.
RAProd	…production, on scale from 1 = agree, 5 = don't agree.
RAFin	…financial issues, on scale from 1 = agree, 5 = don't agree.

[42] According to German soil evaluation law (Bodenschätzungsgesetz - BodSchätzG, 2007).

[43] Education levels are: 1 = no degree, 2 = secondary school certificate (9 years), 3 = secondary school certificate (11 years), 4 = advanced technical college certificate, 5 = high school diploma, 6 = completed vocational training, 7 = certified manager, 8 = certified agriculturist and 9 = masters certificate in agriculture.

Table 5.2: Summary statistics of explanatory variables

Variable	Full sample N = 156			No diversification N = 32			Diversification N = 124			Mann-Whitney U-test
	N	mean	SD	N	mean	SD	N	mean	SD	p-value
DistUrb	132	7.19	5.79	26	9.35	6.74	106	6.66	5.44	0.0253
SoilQual	155	56.08	12.91	31	56.87	12.04	124	55.89	13.16	0.6658
Size	154	55.41	55.73	32	41.19	46.88	122	59.14	57.41	0.0304
HighVCrops	156	0.13	0.34	32	0.03	0.18	124	0.15	0.36	0.0672
IntLivestock	156	0.27	0.44	32	0.28	0.46	124	0.27	0.44	0.8662
Full-time	156	0.54	0.50	32	0.34	0.48	124	0.60	0.49	0.0107
Age	144	50.40	10.68	28	54.29	10.17	116	49.47	10.63	0.0966
Educ	153	6.17	1.95	31	6.13	2.31	122	6.18	1.85	0.6645
Succession	144	0.10	0.88	30	-0.30	1.07	114	0.21	0.79	0.0171
HHS	155	3.66	1.56	32	3.25	1.59	123	3.76	1.55	0.0749
PercMarkRisk	156	2.72	1.47	32	2.45	1.25	124	2.79	1.52	0.3484
PercInstRisk	156	2.78	1.36	32	2.91	1.31	124	2.75	1.38	0.5832
PercProdRisk	156	2.38	1.74	32	2.38	1.75	124	2.38	1.75	0.9064
PercLabRisk	156	1.19	1.43	32	0.97	1.33	124	1.25	1.46	0.1729
LossMarkRisk	156	0.55	0.50	32	0.59	0.50	124	0.54	0.50	0.5909
LossProdRisk	156	0.17	0.38	32	0.16	0.37	124	0.18	0.38	0.7810
LossInstRisk	156	0.42	0.49	32	0.41	0.50	124	0.42	0.50	0.8957
RA	156	6.10	2.35	32	7.19	1.69	124	5.81	2.41	0.0037
RAAgric	156	3.37	1.07	32	3.66	0.97	124	3.30	1.09	0.1000
RAMark	156	3.27	1.12	32	3.41	0.91	124	3.23	1.17	0.3947
RAProd	156	3.24	1.09	32	3.56	0.91	124	3.16	1.11	0.0443
RAFin	156	3.67	1.23	32	4.03	1.12	124	3.57	1.24	0.0543

5.4 Econometric model specification

We assume that each farmer has perfect discrimination capability between the risks of different strategic choices, so that the strategy chosen by each farmer to maximize individual utility as outlined in section 2. Reflecting the decision making process with respect to diversification, we empirically investigate two steps: i) a discrete choice to engage in on-farm diversification activities or not, ii) the choice of intensity (i.e. how many different diversification activities are carried out). We assume that the determinants at both steps do not necessarily have to be identical and equally important. The first step is in the Poisson hurdle model referred to as an equation of participation and the second is referred to as a model of event count that is conditioned on the outcome of the first decision (Greene, 2002).

Based on these assumptions we define the underlying unobservable utility function (y_i^*) of the i-th farmer as a linear function of farm, farmer and geographical characteristics (X_i). The first step can be modeled as a binary choice of the farmer to diversify or not to diversify. This implies that each farmer i chooses to diversify $j = 1$ or not to diversify $j = 0$ depending on the observed characteristics X_i. Hence the probability that the farm is diversified is given by:

$$y_{i,j}^* = \alpha_j X_i + \varepsilon_{i,j} \qquad \forall\, i = 1, \ldots N;\; j = (0,1) \tag{1}$$

Where α_j is the vector of estimated coefficients associated with the diversification decision and $\varepsilon_{i,j}$ is the unobservable error term. The first hurdle, estimating determinants for the farmers decision to diversify or not, was modeled using a binary logit model. The diversified farmer's decision on how many activities to engage in can be modeled as a truncated count model with possible outcomes ranging from minimum 1 to a maximum of K diversification activities. We assume again an underlying unobservable utility function (u_i^*) of the i-th farmer as a linear function of farm, farmer and geographical characteristics (Z_i):

$$u_{i,j}^* = \beta_j Z_i + \upsilon_{i,j} \qquad \forall\, i = 1, \cdots N;\; \forall\, j = 1, \cdots K \tag{2}$$

Where β_j is the vector to be estimated, $\upsilon_{i,j}$ is the unobservable error term. To estimate equations 1 and 2, we have chosen a Poisson hurdle model. It was chosen over alternative models dealing with excess zeros (e.g. zero-inflated count model or Heckman model), because the nature of zeros (no diversification) is unlikely due to sampling but an alternative farm management strategy. Furthermore, contrary to the alternative Tobit model, the hurdle model acknowledges that the decision to diversify and diversification intensity are determined by different processes (Ricker-Gilbert, Jayne, and Chirwa, 2011). This is plausible for the analysis, since factors such as risk preference affect the choice to diversify possibly different than the choice of diversification intensity. Likelihood ratio (LR) was used in $\chi2$ tests to compare the Poisson model to the alternative negative binomial regression Model (Long, 1997, Zeileis, Kleiber, and Jackman, 2008). We find that no over-dispersion of the data can be detected, and the estimated coefficient, is not significantly different from zero, suggesting that the Poisson is appropriate. Furthermore, the logit-Poisson hurdle model is tested against the logit-negative binomial hurdle model. Comparing Akaike's information criterion (AIC) and applying the Vuong test shows that the Poisson-hurdle model is superior to the negative binomial hurdle model (Zeileis, Kleiber, and Jackman, 2008). The empirical analysis is conducted using the statistical software R (packages plyr, psych and lmtest are used) (R Core Team, 2016). All codes and data are available from the authors upon request.

5.5 Results and discussion

The results from the double hurdle analysis are presented in Table 5.3. In order to evaluate which risk preference elicitation method better pertains the farmers’ behavior, we apply the introduced double hurdle model to the two risk preferences elicitation methods (i.e. measuring general risk attitude (see model 1) and domain specific risk attitude (see model 2) separately. The results are consistent over both models, with respect to the signs of the estimated coefficients. Nevertheless, the general self-assessment of risk aversion performs better in explaining the farmer's behavior in our sample and further interpretations are hence based on model 1.

Our analysis shows no significant influence of the farms geographical environment on neither the farmer's decision on diversification nor the diversification intensity. Within our sample, farms are highly diversified using the advantages of the proximity to an urban agglomeration. Due to the high population density and polycentric character of the case study region, it is difficult to identify the influence of geographical characteristics in our sample. The peri-urban environment of the case study area is predicted to have distinct effects on different on-farm non-agricultural diversification activities. Zasada et al. (2011) highlight that for instance, direct sale and equestrian services are of particular relevance in areas close to cities due to their sensitive local consumer demand, while this is different for other diversification activities, like agritourism, gastronomy and accommodation requiring a certain distance to settlement areas for urban dwellers' recreation in the countryside. Farm's producing high value crops such as horticulture or permanent crops are found to be more likely to engage in a larger portfolio of different diversification activities. These farm types are more likely to exploit the advantages of short supply chains, direct marketing opportunities and the increased environmental awareness of consumers regarding agricultural production in peri-urban areas (Zasada et al., 2011, Aubry and Kebir, 2013, Kneafsey, 2010). Additionally, farms producing high value crops with a higher probability to engage in on-farm sale activities are often combining them with gastronomy and other agritourism activities (Haugen and Vik, 2008, Meraner et al., 2015). Furthermore, our results show that being a full-time farmer is positively correlated with the uptake probability of an on-farm non-agricultural diversification activity. This is in line with findings by Haugen and Vik (2008) and McNally (2001), concluding that on-farm non-agricultural diversification is a survival strategy used by farmers wanting to stay on the farm and earn extra income. Like previous research by McNamara and Weiss (2005) and Barbieri and Mahoney (2009), we find that with the increasing age of the main farm operator, the uptake probability of on-farm non-agricultural diversification activities decreases. Younger farmers are found to strengthen the farm business viability and shift excess labor, land and capital to on-farm diversification ventures. This is additionally supported by the positive effect of succession on the diversification decision. Thus, our findings support Potter and Lobley (1996) life cycle theory, arguing that a successor in place motivates the farm family to build long term stability of the farm business and creating additional income for the next generation's family.

Table 5.3: Estimated results for the double hurdle model

	Model 1		Model 2	
	Diversification choice	Diversification intensity	Diversification choice	Diversification intensity
DistUrb	-0.060 (0.053)	-0.002 (0.016)	-0.060 (0.055)	0.000 (0.017)
SoilQual	-0.035 (0.028)	0.007 (0.007)	-0.059 (0.031)	0.007 (0.007)
Size	-0.000 (0.007)	0.002 (0.002)	0.005 (0.009)	0.002 (0.002)
HighVCrops	1.563 (1.384)	0.501** (0.205)	1.774 (1.330)	0.625** (0.225)
IntLivestock	-0.645 (0.841)	-0.068 (0.195)	-0.627 (0.849)	-0.038 (0.197)
Full-time	1.954** (0.977)	0.139 (0.211)	1.307 (1.018)	0.173 (0.216)
Age	-0.103*** (0.040)	0.010 (0.008)	-0.078** (0.037)	0.012 (0.009)
Educ	-0.270 (0.172)	-0.021 (0.057)	-0.202 (0.176)	-0.036 (0.061)
Succession	0.993*** (0.384)	0.106 (0.129)	0.823** (0.382)	0.077 (0.139)
HHS	-0.135 (0.223)	0.010 (0.055)	-0.168 (0.228)	0.010 (0.056)
PercMarkRisk	0.511* (0.303)	0.059 (0.061)	0.617** (0.305)	0.041 (0.064)
PercInstRisk	-0.375 (0.304)	-0.076 (0.075)	-0.742* (0.407)	-0.101 (0.078)
PercProdRisk	-0.147 (0.232)	0.037 (0.063)	0.033 (0.241)	0.053 (0.065)
PercLabRisk	-0.476* (0.276)	0.123* (0.074)	-0.780** (0.324)	0.115 (0.080)
LossMarkRisk	-2.473** (1.037)	-0.389* (0.211)	-1.946** (0.969)	-0.462* (0.218)
LossProdRisk	1.965** (0.929)	-0.080 (0.188)	1.453* (0.835)	-0.182 (0.201)
LossInstRisk	2.172* (1.166)	0.293 (0.233)	1.144* (1.090)	0.329 (0.246)
RA	-0.614*** (0.229)	0.002 (0.040)		
RAAgric			-0.398 (0.465)	0.193 (0.136)
RAMark			0.393 (0.515)	-0.144 (0.122)
RAProd			0.728 (0.628)	0.004 (0.156)
RAFin			-0.541 (0.407)	-0.100 (0.092)
Intercept	16.038*** (4.695)	-0.430 (0.904)	12.125** (4.011)	-0.180 (0.960)
Log-likelihood		-170.1 on 38 Df		-170 on 44 Df
Wald Chisq		52.289**		57.023*

* Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level

Besides observable characteristics and the geographical farm environment, we included elements of the farmer's personal frame of reference (i.e. risk perception, past experiences and risk aversion). We find that the perception of risk influences the diversification decision as well as the diversification intensity. Farmers perceiving market and price risks to be high are more likely to engage in on-farm non-agricultural diversification. This finding corresponds with previous findings by Assefa, Meuwissen, and Oude Lansink (2016) and van Winsen et al. (2014) who conclude that farmers perceiving risks to be very severe use mainly long term survival strategies such as diversification to cope. Contrarily, we find that farmers perceiving labor risks to be high are less likely to diversify. These farmers are more likely to avoid employing additional workforce that might be required for an expansion diversification activities. In contrast, the available labor force is used in conventional agricultural activities. When analyzing the effect of high labor risk perception in the diversification intensity among farmers that have chosen to diversify, we find that high labor risk perception increases the uptake probability of greater diversification intensity of on-farm diversification strategies. Most on-farm diversification strategies are labor intensive activities, often requiring additional hired labor, which is in turn increasing the risk perception stemming from the additional workforce employed at the farm. We find that the general decision to diversify as well as the diversification intensity is influenced by the farmers' past experiences. Farmer that have encountered major losses due to market risks (e.g. volatile input and output prices) are less likely to engage in on-farm non-agricultural diversification activities. The same effect is found for diversification intensity. Thus, there is evidence that farmers with negative experiences due to agricultural market risks choose a specialization strategy over on-farm non-agricultural diversification. Furthermore, we find that farmers that experienced past losses due to institutional risks (e.g. change of subsidies, changes in legal environments) are more likely to engage in on-farm non-agricultural diversification. The current European Union's agricultural policy shifts away from a mono-functional production-oriented support scheme towards supporting the multifunctional characteristics of agriculture (Zasada, 2011). Thus, our finding support conclusions drawn by Weltin et al. (2017), that more on-farm non-agricultural diversification would be pursued by farmers in a scenario of total abolishment of the current European CAP subsidies. Additionally, past losses due to agricultural production risks increase the farmer's uptake probability of on-farm non-agricultural diversification activities. For farmers experiencing weather shocks, pests or other production related risks, on-farm non-agricultural diversification is an option to stay on the farm but reallocate their resources away from the risky agricultural production. Farmers revealing more risk averse preferences, elicited via self-assessment, are significantly less likely to engage in on-farm non-agricultural diversification. This is in line with findings by Meuwissen, Huirne, and Hardaker (2001) and McNamara and Weiss (2005) who argue that very risk averse farmers choose to shift the agricultural risk to third parties (e.g. insurance) over on-farm diversification. In peri-urban areas off-farm opportunities are more attractive compared to rural areas, thus on-farm diversification is associated with higher opportunity costs, contributing to our result.

5.6 Conclusion

Explaining farm diversification is particularly relevant in urban and peri-urban settings where the interrelation with non-farming actors is particularly large and thus determines farmers' decision making process and farm structures. Our results show very high shares of diversified farms in the peri-urban Ruhr metropolitan region. Policies should therefore be tailored to account for the special role of these farming systems, with respect to, but also beyond diversification decisions. Our results have, however, not been able to identify clear effects of different geographical determinants. Future research should focus on more heterogeneous regions, e.g. by explicitly going beyond the analysis of farms within the metropolitan region. Although market opportunities are essential if farmers are to diversify, this paper shows that not all farms are in a similar position to take advantage of existing opportunities. In particular we show that the frame of reference is important when analyzing the farmer's diversification decision and intensity. We find that risk preferences determine diversification decisions. More specifically, risk averse farmers are less likely to engage in on-farm non-agricultural diversification activities but rather tend towards specialization strategies. This will help further disentangle the complex decision making process of on-farm risk management strategies. Our finding that risk perception and the experience of severe losses in the past act as important driver of the uptake of diversification decisions reveals that increasing climatic and market risks coupled with an increasing likelihood of the occurrence of extreme events (e.g. due to climate change and increasing liberalization of markets) might contribute to further diversification of farms. This might create lock-in situations (e.g. Ding, Schoengold, and Tadesse, 2009), as the uptake of diversification is based on large investments. Subsequent research has to identify if the uptake of these diversification activities is a first step into the leave of the agricultural sector, as this would have major implications for the provision of food and other ecosystem services from the agricultural sector (e.g. Mishra, Fannin, and Joo, 2014). Along these lines, the analysis of entry and exit into specific diversification activities, as well as the interrelation with off-farm risk allocation of resources should be conducted. Furthermore, it is reasonable to argue that the farmer's diversification decision and diversification intensity decision should be analyzed using a longer run horizon. Thus, our findings encourage the use of panel data when analyzing the farmer's decision making process in future research.

5.7 References

Assefa, Tsion T., Miranda P. M. Meuwissen, and Alfons G. J. M. Oude Lansink. 2016. "Price risk perceptions and management strategies in selected European food supply chains: An exploratory approach." *NJAS - Wageningen Journal of Life Sciences*.

Aubry, Christine, and Leïla Kebir. 2013. "Shortening food supply chains: A means for maintaining agriculture close to urban areas? The case of the French metropolitan area of Paris." *Food Policy* 41:85-93.

Barbieri, Carla, and Edward Mahoney. 2009. "Why is diversification an attractive farm adjustment strategy? Insights from Texas farmers and ranchers." *Journal of Rural Studies* (25):58–66.

Barnes, Andrew P., Helena Hansson, Gordana Manevska-Tasevska, Shailesh S. Shrestha, and Steven G. Thomson. 2015. "The influence of diversification on long-term viability of the agricultural sector." *Land Use Policy* 49:404-412.

Benjamin, Catherine, and Ayal Kimhi. 2006. "Farm work, off-farm work, and hired farm labour: estimating a discrete-choice model of French farm couples' labour decisions." *European Review of Agricultural Economics* 33 (2):149-171.

Bodenschätzungsgesetz - BodSchätzG. (2007) Gesetz zur Schätzung des landwirtschaftlichen Kulturbodens.

Carter, Sara. 1998. "Portfolio entrepreneurship in the farm sector: indigenous growth in rural areas?" *Entrepreneurship & Regional Development* 10 (1):17-32.

Clark, Jill K., Darla K. Munroe, and Becky Mansfield. 2010. "What counts as farming: how classification limits regionalization of the food system." *Cambridge Journal of Regions, Economy and Society* 3 (2):245-259.

Ding, Ya, Karina Schoengold, and Tsegaye Tadesse. 2009. "The Impact of Weather Extremes on Agricultural Production Methods: Does drought increase adoption of conservation tillage practices?" *Journal of Agricultural and Resource Economics*:395-411.

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, and Gert G. Wagner. 2011. "Individual risk attitudes: Measurement, determinants, and behavioral consequences." *Journal of the European Economic Association* 9 (3):522–550.

Dries, Liesbeth, Stefano Pascucci, and Cornelis Gardebroek. 2012. "Diversification in Italian farm systems: Are farmers using interlinked strategies?" *New Medit* 11 (4):7–15.

Ernwein, Marion. 2014. "Framing urban gardening and agriculture: On space, scale and the public." *Geoforum* 56:77-86.

European Parliamentary Research Service. 2016. *Farm diversification in the EU*. European Parliament: Briefing.

Greene, William H. 2002. *Econometric analysis*. 5 ed. Upper Saddle River USA: Pearson Education, Inc.

Hansson, Helena, Richard Ferguson, Christer Olofsson, and Leena Rantamäki-Lahtinen. 2013. "Farmers' motives for diversifying their farm business – The influence of family." *Journal of Rural Studies* 32:240-250.

Haugen, Marit S., and Jostein Vik. 2008. "Farmers as entrepreneurs: the case of farm-based tourism." *International Journal of Entrepreneurship and Small Business* 6 (3):321-336.

Heimlich, Ralph E., and Charles H. Barnard. 1992. "Agricultural adaptation to urbanization: Farm types in northeast metropolitan areas." *Northeastern Journal of Agricultural and Resource Economics* 21 (1):50-60.

Ilbery, Brian W. 1991. "Farm diversification as an adjustment strategy on the urban fringe of the West Midlands." *Journal of Rural Studies* 7 (3):207–218.

IT.NRW. 2011. "Agricultural Census Data 2010." Landesbetrieb Information und Technik Nordrhein-Westfalen accessed 31.01.2016. https://www.landesdatenbank.nrw.de/ldbnrw/online.

Jarosz, Lucy. 2008. "The city in the country: Growing alternative food networks in Metropolitan areas." *Journal of Rural Studies* 24 (3):231–244.

Kahneman, Daniel, and Amos Tversky. 1979. "Prospect theory: An analysis of decision under risk." *Econometrica: Journal of the Econometric Society*:263-291.

Kneafsey, Moya. 2010. "The region in food—important or irrelevant?" *Cambridge Journal of Regions, Economy and Society*:rsq012.

Lange, Andrej, Annette Piorr, Rosemarie Siebert, and Ingo Zasada. 2013. "Spatial differentiation of farm diversification: How rural attractiveness and vicinity to cities determine farm households' response to the CAP." *Land Use Policy* 31:136–144.

Long, Scott J. 1997. *Regression models for categorical and limited dependent variables*. Vol. 7, *Advanced quantitative techniques in the social sciences*. Thousand Oaks, USA: SAGE Publications Inc.

Lovell, Sarah Taylor. 2010. "Multifunctional urban agriculture for sustainable land use planning in the United States." *Sustainability* 2 (8):2499-2522.

McClintock, Nathan. 2010. "Why farm the city? Theorizing urban agriculture through a lens of metabolic rift." *Cambridge Journal of Regions, Economy and Society* 3 (2):191-207.

McNally, Sandra. 2001. "Farm diversification in England and Wales — what can we learn from the farm business survey?" *Journal of Rural Studies* 17 (2):247-257.

McNamara, Kevin T., and Christoph Weiss. 2005. "Farm Household Income and On- and Off-Farm Diversification." *Journal of Agricultural and Applied Economics* 37 (1):37-48.

Menapace, Luisa, Gregory Colson, and Roberta Raffaelli. 2013. "Risk aversion, subjective beliefs, and farmer risk management strategies." *American Journal of Agricultural Economics* 95 (2):384–389.

Meraner, Manuela, Wim Heijman, Tom Kuhlman, and Robert Finger. 2015. "Determinants of farm diversification in the Netherlands." *Land Use Policy* 42:767-780.

Meuwissen, Miranda P. M., Rudd B. M. Huirne, and Brian J. Hardaker. 2001. "Risk and risk management: an empirical analysis of Dutch livestock farmers." *Livestock Production Science* 69 (1):43–53.

Meyer, Jack. 2002. "Expected Utility as a Paradigm for Decision Making in Agriculture." In *A Comprehensive Assessment of the Role of Risk in U.S. Agriculture*, edited by Richard E. Just and Rulon D. Pope, 3-19. Boston USA: Springer US.

Mishra, Ashok K., Hisham S. El-Osta, and Carmen L. Sandretto. 2004. "Factors affecting farm enterprise diversification." *Agricultural Finance Review* 64 (2):151-166.

Mishra, Ashok K., Mathew J. Fannin, and Hyunjeong Joo. 2014. "Off-Farm Work, Intensity of Government Payments, and Farm Exits: Evidence from a National Survey in the United States." *Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie* 62 (2):283-306.

Mok, Hoi-Fei, Virginia G. Williamson, James R. Grove, Kristal Burry, Fiona S. Barker, and Andrew J. Hamilton. 2014. "Strawberry fields forever? Urban agriculture in developed countries: a review." *Agronomy for Sustainable Development* 34 (1):21-43.

Monaco, Federica, Ingo Zasada, Dirk Wascher, Matjaž Glavan, Marina Pintar, Ulrich Schmutz, Chiara Mazzocchi, Stefano Corsi, and Guido Sali. 2017. "Food Production and Consumption: City Regions between Localism, Agricultural Land Displacement, and Economic Competitiveness." *Sustainability* 9 (1):96.

Opitz, Ina, Regine Berges, Annette Piorr, and Thomas Krikser. 2016. "Contributing to food security in urban areas: differences between urban agriculture and peri-urban agriculture in the Global North." *Agriculture and Human Values* 33 (2):341-358.

Pölling, Bernd, Marcus Mergenthaler, and Wolf Lorleberg. 2016. "Professional urban agriculture and its characteristic business models in Metropolis Ruhr, Germany." *Land Use Policy* 58:366-379.

Pölling, Bernd, W. Sroka, and Marcus Mergenthaler. submitted. "Success of urban farming's city-adjustments and business models – Findings from a survey among farmers in Ruhr Metropolis, Germany." *Land Use Policy*.

Potter, Clive, and Matt Lobley. 1996. "The farm family life cycle, succession paths and environmental change in Britain's countryside." *Journal of Agricultural Economics* 47 (1-4):172-190.

R Core Team. 2016. "R: A language and environment for statistical computing." http://www.R-project.org/.

Ricker-Gilbert, Jacob, Thomas S. Jayne, and Ephraim Chirwa. 2011. "Subsidies and Crowding Out: A Double-Hurdle Model of Fertilizer Demand in Malawi." *American Journal of Agricultural Economics* 93 (1):26-42.

Slovic, Paul, Baruch Fischhoff, and Sarah Lichtenstein. 1982. "Why Study Risk Perception?" *Risk Analysis* 2 (2):83–93.

Tversky, Amos, and Daniel Kahneman. 1973. "Availability: A heuristic for judging frequency and probability." *Cognitive Psychology* 5 (2):207-232.

van Raaij, Fred W. 1981. "Economic psychology." *Journal of Economic Psychology* 1 (1):1–24.

van Winsen, Frankwin, Yann de Mey, Ludwig Lauwers, Steven van Passel, Mark Vancauteren, and Erwin Wauters. 2014. "Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies." *Journal of Risk Research* 19 (1):56-78.

Weltin, Meike, Ingo Zasada, Christian Franke, Annette Piorr, Meri Raggi, and Davide Viaggi. 2017. "Analysing behavioural differences of farm households: An example of income diversification strategies based on European farm survey data." *Land Use Policy* 62:172-184.

Wilson, Geoff A. 2008. "From 'weak' to 'strong' multifunctionality: Conceptualising farm-level multifunctional transitional pathways." *Journal of Rural Studies* 24 (3):367-383.

Zasada, Ingo. 2011. "Multifunctional peri-urban agriculture—A review of societal demands and the provision of goods and services by farming." *Land Use Policy* 28 (4):639–648.

Zasada, Ingo, Christian Fertner, Annette Piorr, and Thomas Sick Nielsen. 2011. "Peri-urbanisation and multifunctional adaptation of agriculture around Copenhagen." *Geografisk Tidsskrift-Danish Journal of Geography* 111 (1):59–72.

Zeileis, Achim, Christian Kleiber, and Simon Jackman. 2008. "Regression models for count data in R." *Journal of Statistical Software* 27 (8):1-25.