ABSTRACT. In an era where farmers face considerable levels of intertwined risks and uncertainties, farm resilience is developing into a focal point for agricultural policies. Using survey data from 916 Dutch farmers, we explore how risk behavior relates to perceived resilience. We capture the dynamics of resilience thinking by investigating past risk-management portfolios, current risk preferences, future risk perceptions, and perceived resilience. Partial least squares structural equation models (PLS-SEM) indicate that higher perceived robustness, adaptability, and transformability relate to these farmers with a more resilient future. Additionally, results show the importance of risk management in assessing perceived resilience. More specifically, we find that more diverse risk-management portfolios are associated with (i) higher perceived adaptability and (ii) in specific cases, higher perceived transformability.

Key Words: Adaptability; Partial Least Squares Structural Equation Model (PLS-SEM); resilience; risk management; risk perception; risk preference; robustness; transformability

INTRODUCTION

In an unpredictable world with changing economic, environmental, social, and institutional conditions, dealing with risk and uncertainty has always been a ubiquitous feature of agricultural production (Chavas 2011). To cope with these interrelated risks and uncertainties, farm adaptation and transformation are becoming increasingly relevant (Ghahramani and Bowran 2018). Moreover, stimulating farm adaptation and transformation requires a shift from dealing with the expected to the unknown future. Depending on farmers’ ability to overcome the consequences of risks and uncertainties, farm resilience is potentially threatened (Darnhofer 2014). As farmers’ risk-management strategies, risk perceptions, and risk preferences determine how farmers cope with risks (van Winsen et al. 2016, Meraner and Finger 2019), risk behavior is inherently related to resilience. To this end, this paper explores the role of farmers’ risk behavior in assessing perceived farm resilience.

Resilience thinking acknowledges the role of complexity and the unknown in a dynamic farm operating environment (Cabell and Oelofse 2012, Darnhofer 2014). Our understanding of farm resilience is adapted from Meuwissen et al. (2019), who defined resilience as the ability to ensure the provision of functions while facing increasingly complex and accumulating economic, environmental, social, and institutional shocks and stresses through the resilience capacities of robustness, adaptability, and transformability. Robustness relates to the capacity to withstand expected and unexpected shocks and stresses (Walker et al. 2009). Adaptability is the capacity to adjust to shocks and stresses by changing the composition of inputs, production, marketing, and risk management (Meuwissen et al. 2019). Transformability is the capacity to radically change the internal farm structure to cope with severe shocks and enduring stresses, which might also imply the delivery of alternative and/or additional farm functions (Meuwissen et al. 2019). Although this social–ecological understanding of resilience underlines the importance of adaptation and transformation, empirical assessments of these capacities remain challenging due to the abstract nature of resilience (Cumming et al. 2005).

As resilience is a latent concept (Clare et al. 2017), indirect assessment methods are required. These assessments can be classified into two approaches. The first approach captures the multidimensionality of resilience by defining several indicators (e.g., Resilience Alliance 2010, Cabell and Oelofse 2012, Choptiany et al. 2017, Jones and Tanner 2017, Diserens et al. 2018, Stone and Rahimifard 2018, Jones and d’Errico 2019). Despite their implicit objective orientation, operationalization and quantification of the resilience indicators remain complex as these resilience assessments are context specific, resulting in incomparable assessments across different regions (Pelling 2011, Jones et al. 2018). The second approach assesses perceived farm resilience (e.g., Marshall et al. 2011, Béné et al. 2012, Marshall and Smaïgl 2013, Marshall et al. 2014, Peerlings et al. 2014, Jones et al. 2018, Jones and d’Errico 2019). This approach recognizes farmers’ ability to judge their own resilience capacities (Jones et al. 2018) and explains behavior and decision making under risk and uncertainty (Jones and d’Errico 2019). Additionally, perceived resilience assessments allow for comparison across regions, as the questions are applicable in other contexts (Clare et al. 2017). Our perception-based approach uses self-assessment questions to measure farmers’ robustness, adaptability, and transformability.

Although perceived resilience and risk behavior are evidently related (Ansah et al. 2019), no empirical applications exist that simultaneously investigated how risk management, preferences, and perceptions are associated with perceived farm resilience. Previous studies succeeded in partially capturing these relationships, including how single risk-management strategies might enhance specified farm resilience—the resilience to deal with one specific risk (Carpenter et al. 2001, Folke 2016). For instance, there is mixed evidence on how diversification might enhance perceived resilience to cope with agricultural policy changes. Peerlings et al. (2014) found that specialized farmers perceived themselves as more resilient, whereas Sutherland et al. (2017) showed that Scottish crofters applied diversification into agritourism and forestry as an adaptation strategy to agricultural policy changes. However, these studies did not account for the
unknown as they target one specific risk. We investigate general resilience, which is more complex than specified resilience as it embodies dealing with risk in general (Folke 2016) and the unknown (Carpenter et al. 2012). A broad view on risk management, which embraces a portfolio of strategies, is likely to be required to prepare farmers for an unknown future. Although several empirical investigations explain why farmers adopt certain risk-management portfolios (Coffey and Schroeder 2019, Meraner and Finger 2019, Vigani and Kathage 2019), none of these studies connected farmers’ risk-management portfolios to general resilience. To fill this research gap, this study investigates how farmers’ risk behavior is associated with general resilience.

A decent farm income helps ensure farm continuity (Saint-Cyr et al. 2019) and foster resilience (Cabell and Oelofse 2012). In resilience thinking, farm income is considered as one of the functions provided by farmers (Meuwissen et al. 2019). Other examples of farm functions are maintaining natural resources in good condition, managing animal welfare, or providing employment and good working conditions. Farmers often pursue a combination of economic and noneconomic functions (Anderson and McLachlan 2012); however, a decent farm income is required to facilitate other functions (ten Napel et al. 2006). Therefore, it is worth investigating how farm income shapes perceived resilience.

Against this background, we aim to explore the relationship between farmers’ risk behavior and perceived resilience. This paper expands the current literature in two ways: (1) we examine how farmers’ risk-management portfolios, perceptions, and preferences are related to perceived general resilience in terms of robustness, adaptability, and transformability, and (2) we explore how farm income explains differences in perceived resilience. Our empirical application focuses on Dutch farmers, who have recently faced a complex mix of risks. Therefore, Dutch farmers are a relevant population for resilience research.

CONCEPTUAL FRAMEWORK

We build upon agricultural risk behavior (Hardaker et al. 2015) and resilience theory (Holling 1973, Darnhofer 2014, Folke 2016) to explore how risk management, perceptions, and preferences relate to perceived resilience (Fig. 1). Our conceptual framework describes (1) the relationship between risk-management portfolios, perceptions, and preferences, (2) how perceived robustness, adaptability, and transformability relate to perceived resilience, (3) the relationship between risk behavior and perceived resilience, and (4) how several control variables relate to risk behavior and perceived resilience. Capturing backward- and forward-looking system dynamics is required to assess resilience (Folke 2016). Therefore, we investigate farmers’ past perceptions ($t-k$), current perceptions ($t$), and perceptions of future events ($t+k$), where $t-k$ refers to the past 5 years, $t$ refers to the current year,
and t+k refers either to the next 5 or 20 years. The next subsections will discuss the various building blocks of the conceptual framework.

**Risk behavior**

Risk-behavior theory uses static approaches to investigate the complex interactions between farmers’ current risk-management decisions, risk perceptions, and risk preferences (Meuwissen et al. 2001, Meraner and Finger 2019). This simplified representation of risk behavior does not account for the influence of past behavior on current or future decision making under risk (van Winsen et al. 2016). To this end, we use a dynamic approach that accounts for farmers’ risk-management portfolio in the last 5 years, current risk preferences, and future risk perceptions over the next 20 years. As past risk-management decisions cannot be explained by current or future perceptions, we investigate the role of past risk-management strategies in shaping current risk preferences and future risk perceptions.

Traditional understandings of risk management primarily underlined the economic dimension of risk coping. For instance, Schmit and Roth (1990) defined risk management as the strategies to minimize the costs of risks regarding potential losses, while considering the costs of risk reduction. In the context of resilience, we understand risk management as the portfolio of strategies that farmers adopt to minimize the impact and potential costs of risk on economic, environmental, and social farm functions. Risk perceptions are farmers’ subjective interpretations of domain-specific risks (Meraner and Finger 2019). To account for domain specificity, we selected eight predefined risk-perception domains (Fig. 1). Risk preferences are a farmer’s orientation toward taking or avoiding risk (Gardebroek 2006, van Winsen et al. 2016). Farmers can range from risk averse to risk neutral to risk taking, and most empirical findings suggest that farmers are to some degree risk averse (Iyer et al. 2019). Therefore, more risk-averse farmers will be referred to as farmers with low risk preferences, and less risk-averse farmers are those farmers with high risk preferences. Heterogeneity in risk preferences is shaped by differences in wealth or farm income (Dohmen et al. 2011, van Winsen et al. 2016), and can be further explained by several other farm and farmer characteristics, including age (Dohmen et al. 2017), gender (Dohmen et al. 2011), and farm size (van Winsen et al. 2016).

We expect that farmers who have adopted a more diverse risk-management portfolio in the last 5 years have taken more actions to reduce the presence of risk (van Winsen et al. 2016). Therefore, they will be better equipped to cope with future risks. Hence, hypothesis 1a (H1a) states that farmers with a more diverse risk-management portfolio in the last 5 years will perceive lower future risk (Table 1). Furthermore, a more diverse risk-management portfolio over the last 5 years allows farmers to take more risks as it widens response options to risks. We hypothesize that farmers with more diverse risk-management portfolios over the last 5 years are less risk averse (H1b). Several lines of evidence suggest that less risk aversion results in lower perceived risk (Keil et al. 2000, Cho and Lee 2006, van Winsen et al. 2016). Therefore, we argue that less risk-averse farmers are expected to have lower future risk perceptions, as they perceive future risky situations as less severe (H1c).

Table 1. Overview of the hypothesized relationships and their expected signs. + positive relationship, - negative relationship, -/+ the relationship will be determined by the study

| Relationship | Expected sign |
|-------------|---------------|
| H1a Risk management (t-k) → risk perceptions (t+k) | - |
| H1b Risk management (t-k) → risk preferences¹ (t) | + |
| H1c Risk preferences (t) → risk perceptions (t+k) | - |
| H2a Robustness (t) → resilience (t+k) | + |
| H2b Adaptability (t) → resilience (t+k) | + |
| H2c Transformability (t) → resilience (t+k) | + |
| H3a Risk management (t-k) → robustness (t) | + |
| H3b Risk management (t-k) → adaptability (t) | + |
| H3c Risk management (t-k) → transformability (t) | + |
| H4a Risk perceptions (t+k) → robustness (t) | - |
| H4b Risk perceptions (t+k) → adaptability (t) | - |
| H4c Risk perceptions (t+k) → transformability (t) | - |
| H5a Risk preferences (t) → robustness (t) | - |
| H5b Risk preferences (t) → adaptability (t) | -/+ |
| H5c Risk preferences (t) → transformability (t) | + |

¹ In this study, risk preferences are understood as a scale ranging from risk averse to risk taking. Therefore, the positive sign indicates that farmers with more (less) diverse risk-management portfolios are expected to be less (more) risk-averse farmers. This applies to all hypotheses.

**Resilience**

Resilience theory describes how robustness, adaptability, and transformability are exploited to manage a dynamic and uncertain world (Folke 2016). The importance of the three complementary resilience capacities depends on the context in which farms operate, the timescale, and the depth of change (Cabell and Oelofse 2012, Termeer et al. 2019). In a predictable era of slow and marginal changes, the farm focus will be more on robustness and adaptability, whereas farmers need to emphasize the ability to transform in a period of radical change (Darnhofer 2014, Béné and Doyen 2018). Our conceptual framework describes how these resilience capacities jointly shape farmers’ perception of future resilience. To this end, we expect that an improved ability to absorb, adapt, or radically change ensures the provision of farm functions (Meuwissen et al. 2019). Therefore, we hypothesize that higher perceived robustness, adaptability, or transformability are related to higher future farm resilience (H2a–2c).

Besides describing how farmers exploit their resilience capacities, resilience theory emphasizes the importance of delivering essential farm functions (i.e., the delivery of public and private goods) (Walker et al. 2004, Meuwissen et al. 2019). We account for farm functions by considering how farm income might explain differences in perceived resilience. Several studies have begun to examine how farmers with different financial goals and functions differ in terms of risk behavior (Greiner et al. 2009, Greiner and Gregg 2011, Bopp et al. 2019). We will expand this conceptual lens by comparing the perceived resilience of two groups: a group of farmers who perceived obtaining farm income as more important and a group who perceived obtaining farm income as less important.

**From risk behavior to perceived resilience**

Understanding the relationship between risk behavior and perceived resilience requires thorough insights into the
interactions among risk management, perceptions, preferences, and perceived resilience capacities. Both risk and resilience literature describe how risk-related variables help to explain resilience (e.g., Scholz et al. 2012, Park et al. 2013, Aven 2017, 2019). Therefore, we describe how risk management, preferences, and perceptions are related to perceived resilience (Marshall and Marshall 2007, Grothmann and Patt 2005, Marshall and Stokes 2014, Marshall et al. 2014).

Farmers with more diverse risk-management portfolios enhance their response diversity, which helps them to deal with unknown future risks (Resilience Alliance 2010). An increased response diversity to risks will help farmers improve their capacity to absorb negative consequences, adjust responses, or radically change their farm. Therefore, farmers with a more diverse portfolio of risk-management strategies over the last 5 years are expected to perceive themselves as more robust, adaptable, and transformable (H3a – 3c).

Ansah et al. (2019) described that risk perceptions negatively shape all perceived resilience capacities because farmers with higher risk perceptions struggle more to overcome the consequences of risks. The separate relationship between risk perceptions and perceived robustness (Marshall and Marshall 2007), adaptability (Marshall and Stokes 2014), or transformability (Marshall et al. 2014) has been examined. For instance, Marshall et al. (2014) found that higher risk perceptions restricted farmers’ ability to identify new transition opportunities, constraining perceived transformability. Extrapolating the findings of Marshall et al. (2014) to all perceived resilience capacities, we expect farmers’ future risk perceptions to be negatively related to perceived robustness, adaptability, and transformability (H4a – 4c).

More risk-averse farmers are less likely to make big and risky investments and are more likely to maintain the status quo (Ansah et al. 2019), whereas less risk-averse farmers are expected to more easily introduce radical changes and are better able to transform. Although some transformations might result in less risky production systems, the radical change toward a new production system is risky and requires willingness to take risk. We expect less risk-averse farmers to perceive themselves as less robust (H5a). The relationship between risk preferences and perceived adaptability could be either positive or negative (H5b), whereas less risk-averse farmers are expected to perceive higher transformability (H5c).

Control variables
We control for farmers’ perceived behavioral control, openness to innovation, and formal and informal networks in relation to perceived resilience. First, perceived behavioral control reflects the perceived ability to overcome obstacles in reaching one’s goals (Ajzen 2002). In this study, perceived behavioral control is framed as a farmer’s perceived ability to deal with risk. Therefore, perceived behavioral control is expected to be positively related to perceived resilience (Ansah et al. 2019) and negatively associated with risk perceptions (van der Linden 2015). Second, more innovative farmers are more likely to try out new farm practices or technologies, which makes them better equipped to change (Glover 2012). We expect a positive relationship between openness to innovation and all perceived resilience capacities. Finally, having a larger informal or formal network improves farmers’ social capital (Hunecke et al. 2017) and is therefore expected to enhance resilience (Cabell and Oelofse 2012).

EMPIRICAL MODEL
To explain the relationship between risk behavior and resilience theory (Fig. 1), a partial least squares structural equation model (PLS-SEM) was estimated using Smart PLS 3 (Ringle et al. 2015). Most of the elicited constructs are latent, indicating that they cannot be directly observed and measured. PLS-SEM is a nonparametric multivariate technique that investigates latent constructs by combining the structural model, which specifies the relationships between latent constructs, and the measurement model (Hair et al. 2016). Measurement models specify how each latent construct was formatively or reflectively measured. Formative measurement models present a relationship from indicators to latent constructs, where changing indicators cause the construct to change (Diamantopoulos and Winklhofer 2001, Sarstedt et al. 2017). Reflective measurement models explain the relationship from the latent construct to the indicators, where a change in the latent construct reflects on the indicators (Bollen and Lennox 1991, Diamantopoulos and Siguaw 2006). As our study is exploratory and combines formative and reflective measurement models into a complex model, PLS-SEM is the most suitable estimation approach (Hair et al. 2017). We followed the measurement invariance of the composite models (MICOM) procedure (Henseler et al. 2016) to account for observed heterogeneity based on the perceived importance of farm income. This procedure determines if the data set is suitable for multigroup analysis (MGA).

DATA
A survey among Dutch farmers was conducted to assess how risk behavior is associated with perceived resilience. Two experts of the Dutch Farmers Union and an interdisciplinary group of researchers provided feedback on the survey. Subsequently, four Dutch farmers pretested the survey, after which some statements were reformulated or omitted. The finalized survey was sent out by e-mail in November 2018 to about 9000 randomly selected Dutch farmers, using a database of an agricultural publisher. To the best of our knowledge, the readership of this publisher can be considered to cover the diversity of the Dutch farming sector and comprehensively reflects the sector as a whole. Additionally, we placed advertisements on the website of this publisher and sent a reminder in December 2018 to increase response rates. This resulted in 1537 responses (17% response rate) of which 926 (60.25%) completed surveys without any missing data. The high dropout rate (39.75%) can be explained by the relatively long duration of the survey. We randomly raffled one tablet and 24 vouchers of €25 among the respondents. Ten respondents indicated to be agricultural contract workers and were left out for further analysis, resulting in a final sample of 916 farmers. This sample meets the sample size requirements of Barclay et al. (1995) who recommend a sample size of ten times the largest number of formative indicators in a construct or ten times the largest number of paths going from a construct into the structural model.

The survey was designed to measure six constructs: (1) perceived resilience, (2) risk-management portfolios, (3) risk perceptions, (4) risk preferences, (5) farm functions, and (6) other farmer characteristics. Unless stated otherwise, all items were measured on a seven-point Likert scale. The scores of the negatively worded
items were reversed during the analysis. Table 2 presents the item wordings and summary statistics.

First, farmers selected their adopted risk-management strategies over the past 5 years (RM) from a list of 22 risk-management strategies (Meuwissen et al. 2001, Flaten et al. 2005, van Wissen et al. 2016, Meraner and Finger 2019). These risk-management strategies were classified into seven categories: flexibility, cooperation with others, financial risk management, measures to control environmental risks, specialization, diversification, and learning (see Table A1.1 for more details). An index of farmers’ risk-management portfolios was created by counting in how many categories at least one strategy was selected.

Second, we used a subjective approach to elicit farmers’ future risk perceptions (RISK PERC) with respect to 17 risk sources. The selected risk sources were based on a literature review (Meuwissen et al. 2001, van Wissen et al. 2016, Meraner and Finger 2019). Farmers were asked to indicate their expectations about how challenging certain risks would become in the next 20 years in the following domains: input price, market price, financial, supply chain, production, personal and personnel, institutional, and societal (Table 2). We controlled for farmers’ domain-specific risk perceptions as first-order constructs and combined them into a second-order construct that represents general risk perception.

Third, we elicited farmers’ risk preferences (RISK PREF) using a combination of self-assessment and business statements (Iyer et al. 2019). Farmers were asked to provide a general self-assessment of their risk preferences using one reflective item on an 11-point Likert scale (Dohmen et al. 2011). Additionally, we elicited domain-specific risk preferences using five formative business statements (e.g., Meuwissen et al. 2001, Meraner and Finger 2019). These statements elicited farmers’ relative risk preferences—risk preferences relative to other farmers—regarding the following subjects: (1) production, (2) marketing and prices, (3) financial risks, (4) innovation, and (5) farming in general. The fifth statement was excluded from further analysis because it does not represent a specific domain. Therefore, this statement is not suitable to fit into a formative construct that comprises farmers’ general risk preferences based on different domains.

Fourth, perceived farm resilience was measured using an indirect and direct method. Building upon several resilience frameworks (e.g., Marshall and Marshall 2007, Clare et al. 2017, Jones and d’Errico 2019), the indirect approach measured farmers’ perceived robustness (ROB), adaptability (ADAP), and transformability (TRANS) using four statements per category. All resilience capacities were introduced with a nonagricultural example to ensure that farmers understood the statements. Additionally, we used two items to directly elicit farmers’ future resilience (RES) for the next 5 and 20 years.

Fifth, farmers were asked to distribute 100 points over nine farm functions (FUNC). We grouped farmers based on the perceived importance of income as a farm function. The group Low consists of farmers who perceived income as relatively unimportant compared with other farm functions; these farmers distributed less than the median (less than 30 points) to farm income. The group High represents farmers who perceived income as one of the main farm functions (30 or more points).

Finally, we included several statements about farmers’ openness to innovation (INNO), informal networks (NET INF), formal networks (NET FOR), and perceived behavioral control (PBC). Openness to innovation was measured using two items (Aubert et al. 2012). Two sets of three statements were used to measure farmers’ formal and informal networks (Hunecke et al. 2017). Based on Armitage and Conner (1999) and Ajzen (2002), perceived behavioral control was measured as a four-item construct.

RESULTS

The PLS-SEM evaluation consists of the measurement and structural model assessment. The measurement model assessment examines the reflective and formative indicators that are used to operationalize the latent constructs. If sufficient measurement quality is confirmed, the structural model evaluation tests the hypothesized associations between the latent constructs (Hair et al. 2016). Finally, the results of the MGA will be presented.

Measurement model assessment

Evaluating the reflective measurement model includes an assessment of internal consistency reliability, convergent validity, and discriminant validity (Hair et al. 2016). Following the recommendations of Hair et al. (2018) for PLS-SEM with a second-order formative-formative construct, we used the repeated indicators approach with a factor weighting scheme, a maximum of 300 iterations, and a stop criterion of 10−8 as algorithm settings. The evaluation of the full model showed a lack of internal consistency reliability as PBC and ROB obtained Cronbach’s alpha values smaller than 0.7 (Table A1.2). Furthermore, the outer loadings of adap_4 (0.566), pbc_2 (0.695), pbc_4 (0.510), rob_2 (0.180), and trans_2 (0.227) are lower than 0.7, potentially causing low convergent validity. After removing adap_4, pbc_4, rob_2, and trans_2, the internal consistency reliability and convergent validity improved. All Cronbach’s alpha values were larger than 0.7, and all composite reliability values ranged between 0.8 and 0.95 (Table 3). Additionally, all average variance explained (AVE) values exceed 0.5, confirming convergent validity. Discriminant validity is obtained as none of the 95% bias-corrected and accelerated (BCa) confidence intervals of the heterotrait–monotrait (HTMT) ratio (Henseler et al. 2016) include 1 (Table A1.3).

The formative measurement model assessment evaluates convergent validity, collinearity, and the significance of outer weights (Hair et al. 2016). First, a redundancy analysis was conducted to assess convergent validity between the formative and reflective RISK PREF measures. This resulted in a path coefficient with a magnitude of 0.805—exceeding the critical threshold of 0.70 (Sarstedt et al. 2017)—convergent validity was obtained. No redundancy analysis was conducted for RISK PERC and RES because these constructs were respectively a second-order construct or directly elicited. Second, all formative items obtained variance inflation factors (VIF) below 5 (Table A1.4), indicating that collinearity is not present at critical levels. Finally, we assessed the significance of outer weights and the relevance of outer loadings using a bootstrapping procedure (4000 samples, no sign changes option, BCa, two-tailed testing at α=0.05). Aside from farmers’ financial risk preferences (riskpref_3), all formative items obtained significant outer weights (Table A1.4). The factor loading of riskpref_3 exceeds the critical value of 0.50, indicating an absolute contribution to RISK PREF.
### Table 2. Item wordings and summary statistics (n = 916)

| Item‡ | Mean | St dev |
|-------|------|--------|
| Risk behavior | | |
| Risk management (RM) - single item. Eight-point scale, ranging from 0 (no risk management) to 7 (all seven categories in risk management portfolio) | 3.98 | 1.35 |
| Risk perception (RISK PERC) - second-order formative | | |
| Input price risk perception (RISK PERC_1) - first-order formative | | |
| riskpref_1 | 4.44 | 1.53 |
| riskpref_2 | 4.16 | 1.47 |
| Market price risk perception (RISK PERC_2) - first-order formative | | |
| riskpref_3 | 4.91 | 1.62 |
| riskpref_4 | 4.78 | 1.45 |
| Supply chain risk perception (RISK PERC_3) - first-order formative | | |
| riskpref_5 | 4.93 | 1.70 |
| riskpref_6 | 4.02 | 1.54 |
| Financial risk perception (RISK PERC_4) - first-order formative | | |
| riskpref_7 | 4.17 | 1.74 |
| riskpref_8 | 3.42 | 1.75 |
| Production risk perception (RISK PERC_5) - first-order formative | | |
| riskpref_9 | 4.50 | 1.61 |
| riskpref_10 | 4.38 | 1.56 |
| Personal and personnel risk perception (RISK PERC_6) - first-order formative | | |
| riskpref_11 | 3.71 | 1.95 |
| riskpref_12 | 3.20 | 1.67 |
| riskpref_13 | 3.68 | 1.99 |
| Institutional risk perception (RISK PERC_7) - first-order formative | | |
| riskpref_14 | 5.51 | 1.50 |
| riskpref_15 | 4.36 | 1.92 |
| Societal risk perception (RISK PERC_8) - first-order formative | | |
| riskpref_16 | 4.87 | 1.62 |
| riskpref_17 | 4.84 | 1.69 |
| Risk preferences (RISK PREF) - formative | | |
| riskpref_1 | 4.08 | 1.49 |
| riskpref_2 | 4.39 | 1.50 |
| riskpref_3 | 4.15 | 1.40 |
| riskpref_4 | 4.35 | 1.35 |
| Risk preferences (RISK PREF) - reflective. Eleven-point Likert scale ranging from 0–10 | | |
| riskpref_5 | 5.99 | 2.03 |
| Resilience | | |
| Robustness (ROB) - reflective | | |
| rob_1 | 4.21 | 1.43 |
| rob_2 | 3.90 | 1.54 |
| rob_3 | 4.44 | 1.47 |
| rob_4 | 4.02 | 1.53 |
| Adaptability (ADAP) - reflective | | |
| adap_1 | 3.97 | 1.71 |
| adap_2 | 4.58 | 1.42 |
| adap_3 | 4.65 | 1.37 |
| adap_4 | 4.57 | 1.59 |
| Transformability (TRANS) - reflective | | |
| trans_1 | 3.84 | 1.58 |
| trans_2 | 4.08 | 1.56 |
| trans_3 | 3.98 | 1.46 |
| trans_4 | 3.72 | 1.57 |
| Resilience (RES) - formative | | |
| res_1 | 4.87 | 1.47 |
| res_2 | 4.37 | 1.59 |
| Farm functions (FUNC) - formative. 100 points | | |
| func_1 | 36.64 | 20.25 |
| Control variables | | |
| Innovation (INNO) - reflective | | |
| inno_1 | 4.15 | 1.58 |
| inno_2 | 4.12 | 1.58 |
| Informal network (NET INF) - reflective | | |
| net_1 | 5.62 | 1.31 |
| net_2 | 4.98 | 1.47 |
| net_3 | 4.28 | 1.52 |
| Formal network (NET FOR) - reflective | | |
| net_4 | 5.09 | 1.35 |
| net_5 | 4.56 | 1.49 |
| net_6 | 4.66 | 1.50 |
| Perceived behavioral control (PBC) - reflective | | |
| pbc_1 | 4.64 | 1.30 |
| pbc_2 | 4.78 | 1.43 |
| pbc_3 | 3.96 | 1.45 |
| pbc_4 | 4.43 | 1.46 |

‡Unless otherwise stated, all items are measured on a seven-point Likert scale. Reversed scores of the negatively worded items are presented.
(Hair et al. 2016). Furthermore, previous research confirmed the theoretical importance of financial risk preferences (Reynaud and Couture 2012, Iyer et al. 2019). Therefore, we decided to keep riskpref_3 in the structural model assessment because the reflective and formative measurement model assessments suggest satisfactory levels of reliability and validity.

Table 3. Internal consistency reliability and convergent validity of the reduced model

| Cronbach's alpha | Composite reliability | AVE† |
|------------------|-----------------------|------|
| All Low High     | All Low High          | All Low High |
| ADAP             | 0.795 0.811 0.785     | 0.879 0.887 0.874 | 0.710 0.725 0.701 |
| INNO             | 0.856 0.851 0.858     | 0.933 0.930 0.933 | 0.874 0.869 0.875 |
| NET              | 0.813 0.768 0.831     | 0.888 0.866 0.897 | 0.726 0.684 0.744 |
| FOR              | 0.774 0.792 0.765     | 0.869 0.877 0.861 | 0.689 0.707 0.675 |
| INF              | 0.713 0.743 0.693     | 0.837 0.852 0.826 | 0.632 0.657 0.615 |
| PBC              | 0.726 0.713 0.730     | 0.846 0.838 0.847 | 0.646 0.634 0.649 |
| ROB              | 0.846 0.860 0.835     | 0.907 0.915 0.901 | 0.765 0.782 0.752 |
| TRANS            | 0.825 0.802 0.814     | 0.870 0.874 0.878 | 0.745 0.762 0.742 |

†AVE = average variance explained.

Structural model assessment

The structural model assessment evaluates the potential presence of collinearity and the predictive capacity of the PLS-SEM. As the highest VIF value of all predictor constructs is 1.76, we found no indication of the presence of collinearity at critical levels. The second and sixth columns of Table 4 present, respectively, the direct and the total effects, which is the sum of the direct and indirect path coefficients.

Our results indicate that a more diverse risk-management portfolio over the last 5 years is associated with higher future risk perceptions, leading to the rejection of H1a. This suggests that farmers who have adopted risk-management strategies did so to cover the major perceived risks. However, although a more diverse risk-management portfolio might be beneficial to cope with present risks, future risk perceptions remain high as farmers could still be unaware of the consequences. We found support for H1b, indicating that farmers with a more diverse risk-management portfolio in the past are less risk averse. This suggests that a more diverse risk-management portfolio helps farmers to reduce the exposure to risk, which makes farmers less risk averse. As less risk-averse farmers experienced higher future risk perceptions, we rejected H1c. It could be that the current degree of risk aversion reflects on current risks, whereas the consequences of these risks arise in the future. Ultimately, this might increase farmers’ future risk perceptions. Our findings contradict van Wingen et al. (2016), who found domain-specific relationships between risk preferences and perceptions.

The results support H2a–H2c as they suggest that farmers use their capacities to absorb, adapt, or transform in response to future risks, resulting in higher perceived future resilience. Our findings are in line with Darnhofer (2014), Folke (2016), and Meeuwen et al. (2019), who described that higher levels of robustness, adaptability, or transformability are needed to improve resilience.

The nonsignificant relationship between farmers’ past risk-management portfolio and perceived robustness led to the rejection of H3a. The high costs involved in obtaining a diverse risk-management portfolio could restrain farmers from absorbing shocks (Vigani and Kathage 2019). This might indicate that individual financial risk-management strategies are more efficient tools to boost robustness.

More diverse risk-management portfolios are positively related to perceived adaptability (confirming H3b), suggesting that wider response options to future risks increase the maneuvering space of farmers. We reject H3c, as more diverse risk-management portfolios were not related to perceived transformability. A diverse risk-management portfolio alone might not be sufficient to enhance transformability because farmers need to be both able and willing to transform (Tong et al. 2016).

We found support for H4a, as future risk perceptions are negatively related to perceived robustness. Surprisingly, we found that future risk perceptions are unrelated to perceived adaptability and transformability, leading to the rejection of H4b and H4c. These findings contradict previous studies that described how higher risk perceptions partly explain farm adaptation (Grothmann and Patt 2005, Marshall and Stokes 2014) or transformation (Marshall et al. 2014). A potential explanation for this could be that robustness describes the capacity to recover from shocks, which could be perceived as dealing with risks (Bené et al. 2016). Perceived adaptability and transformability are related, respectively, to adjustments or radical changes, which are not reflected by risk perceptions.

Risk preferences are positively associated with perceived robustness, adaptability, and transformability, indicating that less risk-averse farmers perceive higher resilience capacities. Hence, we rejected H5a and found support for H5c. This suggests that less risk-averse farmers have an improved confidence to overcome the negative consequences of risks, which could enable them to better exploit their resilience capacities.

The largest path coefficients were found from perceived behavioral control to perceived robustness (0.351), adaptability (0.371), and transformability (0.385). This suggests that farmers with higher perceived behavioral control were more certain about their ability to tackle risks using their resilience capacities (Clare et al. 2017). Farmers’ formal networks were positively related to robustness and adaptability, whereas informal networks were related to none of the resilience capacities. These findings suggest that farmers could use their formal networks to implement robustness and adaptation strategies, while informal networks are not exploited. Finally, a positive association between innovation and adaptability was found, suggesting that more innovative farmers are better able to adapt. This is line with Anderson and McLachlan (2012), who found that innovative Canadian farmers were able to improve adaptability to overcome mad cow disease.

R² values of 0.186, 0.282, 0.334 were obtained, respectively, for perceived robustness, adaptability, and transformability (Table A1.5). The exploratory aim of this study in combination with the complexity of resilience explains the relatively low R² values. Consequently, the f² effect sizes are relatively low as well (Table A1.6). The out-of-sample predictive relevance is confirmed as all Q² values are above zero (Table A1.5).
### Table 4. Path coefficients of the PLS-SEM. Direct and total effects are reported

| Risk behavior          | Direct effects | Low (n = 329) | High (n = 587) | Difference (Low–High) | Total effects | Low (n = 329) | High (n = 587) | Difference (Low–High) |
|------------------------|----------------|---------------|----------------|------------------------|---------------|---------------|----------------|------------------------|
| RM → RISK PREFERENCES  | 0.237***       | 0.255***      | 0.254***       | -0.027                 | 0.252***      | 0.253***       | 0.253***       | -0.027                 |
| RM → PBC               | 0.109***       | 0.174***      | 0.070*         | 0.098                  | 0.109***      | 0.174***       | 0.176*         | 0.076*                 |
| PBC → RISK PREFERENCES | -0.141***      | -0.132        | -0.143***      | 0.011                  | -0.141***     | -0.132        | -0.134***      | 0.011                  |
| RISK PREFERENCES → RISK PREFERENCES | 0.082* | 0.209***      | -0.007         | 0.217**                | 0.082*        | 0.209***       | 0.217**         | 0.007                  |
| RM → RISK PREFERENCES  | 0.162***       | 0.145**       | 0.144***       | -0.004                 | 0.162***      | 0.145**       | 0.149***       | -0.004                 |
| Robustness             |               |               |                |                        |               |               |                |                        |
| RISK PREFERENCES → ROB | -0.098**       | -0.002        | -0.138***      | 0.138*                 | -0.098**      | -0.002        | -0.139**       | 0.138*                 |
| PBC → RISK PREFERENCES | 0.096**        | 0.205***      | 0.026          | 0.180**                | 0.096**       | 0.205***      | 0.205**       | 0.027                  |
| RM → ROB               | -0.018         | -0.045        | 0.005          | -0.049                 | -0.018        | -0.045        | -0.046         | 0.004                  |
| INNO → ROB             | -0.044         | -0.008        | -0.036         | -0.049                 | -0.044        | -0.008        | -0.036         | -0.049                 |
| NET FOR → ROB          | 0.093**        | -0.017        | 0.148***       | -0.166*                | 0.093**       | -0.017        | 0.149***       | -0.166*                |
| PBC → ROB              | 0.351***       | 0.356***      | 0.350***       | 0.005                  | 0.356***      | 0.356***      | 0.370***       | 0.014                  |
| Adaptability           |               |               |                |                        |               |               |                |                        |
| RISK PREFERENCES → ADAP | 0.028          | 0.017         | -0.059         | 0.076                  | -0.028        | 0.017         | -0.059         | 0.076                  |
| PBC → ADAP             | 0.156***       | 0.141**       | 0.164***       | -0.022                 | 0.156***      | 0.145**       | 0.164***       | -0.019                 |
| RM → ADAP              | 0.057**        | 0.049         | 0.056          | 0.008                  | 0.057**       | 0.049         | 0.057**        | 0.009                  |
| INNO → ADAP            | 0.106***       | 0.058         | 0.132***       | -0.074                 | 0.106***      | 0.058         | 0.132***       | -0.074                 |
| NET FOR → ADAP         | 0.073*         | 0.136**       | 0.041          | 0.095                  | 0.073*        | 0.136**       | 0.142**        | 0.009                  |
| PBC → ADAP             | 0.031          | 0.062         | 0.019          | 0.043                  | 0.031         | 0.062         | 0.019         | 0.043                  |
| Transformability       |               |               |                |                        |               |               |                |                        |
| RISK PREFERENCES → TRANS | -0.047        | -0.054        | -0.035         | -0.018                 | -0.047        | -0.054        | -0.035         | -0.018                 |
| PBC → TRANS            | 0.212***       | 0.202***      | 0.212***       | -0.010                 | 0.212***      | 0.212***      | 0.212***       | -0.010                 |
| RM → TRANS             | -0.027         | 0.000         | -0.045         | 0.046                  | -0.027        | 0.000         | 0.045         | -0.027                 |
| INNO → TRANS           | 0.012          | -0.051        | 0.045          | -0.096                 | 0.012         | -0.051        | 0.045         | -0.096                 |
| NET FOR → TRANS        | 0.062          | 0.055         | 0.071          | -0.016                 | 0.062         | 0.055         | 0.071         | -0.016                 |
| PBC → TRANS            | 0.381***       | 0.422***      | 0.367***       | 0.055                  | 0.381***      | 0.422***      | 0.429***       | 0.055                  |
| Resilience             |               |               |                |                        |               |               |                |                        |
| ROB → RES              | 0.267***       | 0.245***      | 0.289***       | -0.043                 | 0.267***      | 0.245***      | 0.289***       | -0.043                 |
| ADAP → RES             | 0.230***       | 0.284***      | 0.200***       | 0.085                  | 0.230***      | 0.284***      | 0.289***       | 0.085                  |
| TRANS → RES            | 0.114***       | 0.113         | 0.108*         | 0.005                  | 0.114***      | 0.113         | 0.118*         | 0.005                  |
| RISK PREFERENCES → RES | -0.038**       | -0.001        | -0.056**       | 0.054                  | -0.038**      | -0.001        | -0.056**       | 0.054                  |
| PBC → RES              | 0.217***       | 0.271***      | 0.217***       | 0.030                  | 0.217***      | 0.271***      | 0.276***       | 0.030                  |

The domain-specific (first-order) effects of RISK PREFERENCES and most indirect effects are omitted for the sake of brevity. These results can be consulted in Table A.1.10 of Appendix 1. *p ≤ 0.10; **p ≤ 0.05; ***p ≤ 0.01. Asterisks in the fifth and ninth column (Difference (Low–High)) refer to p values of the permutation test.
Multigroup analysis
The MICOM-procedure confirmed partial measurement invariance (Table A1.8 and A1.9), indicating that the subsets Low and High are suitable for MGA to investigate the importance of farm income in predicting differences in perceived resilience (Henseler et al. 2016).

Table 3 shows that the Cronbach’s alpha value of perceived behavioral control for the group High (0.693) is slightly below the threshold of 0.7. No adjustments to the measurement model were made, as it is important to compare exactly the same models while conducting a MGA PLS-SEM. Therefore, we conclude that satisfactory reliability and validity levels of the reflective and formative measurement model were obtained.

Some path coefficients are significant for either Low or High, indicating that both groups have different constructs associated with the perceived resilience capacities (Table 4). The results of the permutation test with 3000 permutations (Chin and Dibbern 2010) indicate significant differences between Low and High for the path coefficients RISK PREF → RISK PERC, RISK PERC → ROB, RISK PREF → ROB and NET FOR → ROB. Noteworthy are the path coefficients RM → TRANS and RM → RES, which are only significant for the group Low. To ensure robust estimation results, a sensitivity analysis with different threshold values for High (i.e., 35, 40, and 45 points) was conducted. No threshold values lower than 30 were selected as this would have resulted in extremely unequal sample sizes of both groups. Almost all path coefficients maintained the same direction and level of significance, indicating fairly robust estimation results. We will further detail the relationship between risk management and perceived transformability.

A more diverse risk-management portfolio is positively related to perceived transformability only for farmers who perceived obtaining farm income as less important. Note that only the total effects are significant, indicating that the sum of the direct and indirect effects together shape perceived transformability. A possible explanation for this could be that farmers who prioritized income less, found a mix of other functions, including the provision of public goods, more important. This could imply that these farmers use risk-management strategies to become better able to transform and obtained higher perceived behavioral control than those farmers who perceived income as more important (Table A1.11). These differences in intrinsic motivations shape farmers’ decision making (Greiner and Gregg 2011) and might be associated with differences in perceived transformability.

DISCUSSION AND CONCLUSIONS
This article explores how risk behavior is related to perceived farm resilience. First, we have examined how farmers’ perceived resilience capacities are associated with future resilience and how risk management, perceptions, and preferences are related to perceived resilience. All perceived resilience capacities are positively associated with perceived future resilience, indicating that the most resilient future farms obtain high levels of perceived robustness, adaptability, and transformability. Additionally, more diverse risk-management portfolios are associated with farmers with higher perceived adaptability and future resilience. Second, we have investigated differences in terms of perceived resilience between farmers who perceive farm income as being less important and those who prioritize farm income. Higher perceived transformability is obtained for farmers who perceive farm income as being less important. A more diverse risk-management portfolio is positively associated with perceived transformability only for these farmers.

To ensure the validity of our findings, a successful translation of the complex and latent nature of perceived resilience into a comprehensible and measurable construct is needed. In other words, it requires translation validity, i.e., the degree to which the operationalized construct is translated into measurable items (Onwuegbuzie et al. 2016). Three actions were taken to ensure translation validity. First, we based our perceived resilience statements on previous frameworks (e.g., Marshall and Marshall 2007, Clare et al. 2017, Jones and d’Errico 2019). Second, all resilience capacities were introduced with a short nonagricultural example to ensure that all statements were commonly interpreted. Third, we received feedback from an interdisciplinary group of researchers and specifically asked farmers to review all resilience statements when we pretested the survey. Several statements were rephrased based on the received feedback. Jointly, these three actions ensure translation validity (Netemeyer et al. 2003).

A limitation of this study is that it did not consider the potential trade-offs between perceived robustness, adaptability, and transformability. For instance, improving perceived robustness by creating financial buffers, might result in farmers who perceive themselves as being less able to adapt or transform. These additional insights are valuable to understand the potential costs of improving one resilience capacity. This motivates future research, which could investigate the potential trade-offs between robustness, adaptability, and transformability using panel data approaches.

Our findings have implications for agricultural policy makers and farmers. First, our results indicate that more diverse risk-management portfolios, consisting of a combination of economic, environmental, and social strategies, are associated with higher perceived adaptability and transformability. Most current European agricultural policies primarily consider robustness and emphasize how to tackle short-term risks (Candel et al. 2018). However, to ensure a resilient future for farmers, policies should also stimulate farm adaptation and transformation (Ohlund et al. 2015). To this end, policy makers could consider shifting from a narrow-minded view on risk management, where one specific tool is emphasized aiming to enhance robustness, to a holistic approach that highlights the importance of diverse risk-management portfolios (Coffey and Schroeder 2019, Meraner and Finger 2019, Vigani and Kathage 2019). In this way, risk management has the potential to enhance adaptability and transformability. Second, this study has implications for farmers because our findings show that resilient farmers combine robustness, adaptability, and transformability to overcome unknown future risks using a diversity of risk-management strategies.

Responses to this article can be read online at: http://www.ecologyandsociety.org/issues/responses.php/11893
Acknowledgments:

This research was undertaken within the SURE-Farm (Towards SUstainable and REsilient EU FARMing systems) project, funded by the European Union (EU) Horizon 2020 research and innovation programme under Grant Agreement No 727520 (http://surefarmproject.eu). The content of this article does not reflect the official opinion of the European Union. Responsibility for the information and views expressed therein lies entirely with the authors. We would like to thank two anonymous reviewers for their helpful suggestions to improve the manuscript. Also, we would like to thank the Dutch farmers who participated in the survey.

Data Availability:

The data that support the findings of this study are openly available in DANS-EASY at https://doi.org/10.17026/dans-zb3-pr06; reference number: 132914. The data will be publicly accessible from June 2021 onward.

LITERATURE CITED

Ajzen, I. 2002. Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. Journal of Applied Social Psychology, 32(4):665–683. http://dx.doi.org/10.1111/1559-1816.2002.tb00236.x

Anderson, C. R., and S. M. Mclachlan. 2012. Extending, enduring and innovating: farm household adaptation to global zoonotic disease. Global Environmental Change 22(1):82–93. http://dx.doi.org/10.1016/j.gloenvcha.2011.11.008

Ansah, I. G. K., C. Gardebroek, and R. Ihle. 2019. Resilience and household food security: a review of concepts, methodological approaches and empirical evidence. Food Security 11(6):1187–1203. http://dx.doi.org/10.1007/s12571-019-00968-1

Armitage, C. J., and M. Conner. 1999. The theory of planned behaviour: assessment of predictive validity and perceived control. British Journal of Social Psychology 38(1):35–54. http://dx.doi.org/10.1348/014466699164022

Aubert, B. A., A. Schroeder, and J. Grimaudo. 2012. IT as enabler of sustainable farming: an empirical analysis of farmers’ adoption decision of precision agriculture technology. Decision Support Systems 54(1):510–520. http://dx.doi.org/10.1016/j.dss.2012.07.002

Aven, T. 2017. How some types of risk assessments can support resilience analysis and management. Reliability Engineering and System Safety 167:536–543. http://dx.doi.org/10.1016/j.ress.2017.07.005

Aven, T. 2019. The call for a shift from risk to resilience: what does it mean? Risk Analysis 39(6):1196–1203. http://dx.doi.org/10.1111/risa.13247

Barclay, D., C. Higgins, and R. Thompson. 1995. The partial least squares (PLS) approach to causal modelling: personal computer adoption and use as an illustration. Technology Studies 2(2):285–309.

Béné, C., and L. Doyen. 2018. From resistance to transformation: a generic metric of resilience through viability. Earth’s Future 6 (7):979–996. http://dx.doi.org/10.1002/2017ef000660

Béné, C., T. Frankenberger, M. Langworthy, M. Mueller, and S. Martin. 2016. The influence of subjective psycho-social factors on people’s resilience: conceptual framework and empirical evidence. CGIAR, Nairobi, Kenya.

Béné, C., R. G. Wood, A. Newsham, and M. Davies. 2012. Resilience: new utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. IDS Working Papers 2012 (405):1–61. http://dx.doi.org/10.1111/j.2040-0209.2012.00405.x

Bollen, K., and R. Lennox. 1991. Conventional wisdom on measurement: a structural equation perspective. Psychological Bulletin 110(2):305–314. http://dx.doi.org/10.1037/0033-2909.110.2.305

Bopp, C., A. Engler, P. M. Poortvliet, and R. Jara-Rojas. 2019. The role of farmers’ intrinsic motivation in the effectiveness of policy incentives to promote sustainable agricultural practices. Journal of Environmental Management 244(1):320–327. http://dx.doi.org/10.1016/j.jenvman.2019.04.107

Cabell, J. F., and M. Oelofse. 2012. An indicator framework for assessing agroecosystem resilience. Ecology and Society 17(1):18. http://dx.doi.org/10.5751/es-04666-170118

Candel, J., K. Termeer, and M. Meuwissen 2018. Letter to the Editor. EuroChoices 17(3):49. http://dx.doi.org/10.1017/1746-692x.12207

Carpenter, S., K. Arrow, S. Barrett, R. Biggs, W. Brock, A.-S. Crépin, G. Engström, C. Folke, T. Hughes, N. Kautsky, C.-Z. Li, G. Mccarney, K. Meng, K.-G. Müller, S. Polasky, M. Schefler, J. Shogren, T. Sternar, J. Vincent, B. Walker, A. Xepapadeas, and A. Zeeuw. 2012. General resilience to cope with extreme events. Sustainability 4(12):3248–3259. http://dx.doi.org/10.3390/su4123248

Carpenter, S., B. Walker, J. M. Anderies, and N. Abel. 2001. From metaphor to measurement: resilience of what to what? Ecosystems 4(8):765–781. http://dx.doi.org/10.1007/s10021-001-0045-9

Chavas, J. P. 2011. Agricultural policy in an uncertain world. European Review of Agricultural Economics 38(3):383–407. http://dx.doi.org/10.1093/erae/jbr023

Chin, W. W., and J. Dibbern. 2010. An introduction to a permutation based procedure for multi-group PLS analysis: results of tests of differences on simulated data and a cross cultural analysis of the sourcing of information system services between Germany and the USA. Pages 171–193 in V. Esposito Vinzi, W. Chin, J. R. Henseler, and H. H. Wang, editors. Handbook of partial least squares. Springer, Berlin/Heidelberg, Germany. https://doi.org/10.1007/978-3-540-32827-8_8

Cho, J., and J. Lee. 2006. An integrated model of risk and risk-reducing strategies. Journal of Business Research 59(1):112–120. http://dx.doi.org/10.1016/j.jbusres.2005.03.006

Choptiany, J. M. H., S. Phillips, B. E. Graeub, D. Colozza, W. Settle, B. Herren, and C. Batello. 2017. SHARP: integrating a traditional survey with participatory self-evaluation and learning for climate change resilience assessment. Climate and Development 9(6):505–517. http://dx.doi.org/10.1080/17565529.2016.1174661

Clare, A., R. Graber, L. Jones, and D. Conway. 2017. Subjective measures of climate resilience: what is the added value for policy and programming? Global Environmental Change 46(1):17–22. http://dx.doi.org/10.1016/j.gloenvcha.2017.07.001
Coffey, B. K., and T. C. Schroeder. 2019. Factors influencing midwestern grain farmers’ use of risk management tools. *Agricultural Finance Review* 79(2):192–203. http://dx.doi.org/10.1108/af-04-2018-0026

Cumming, G. S., G. Barnes, S. Perz, M. Schmink, K. E. Sieving, J. Southworth, M. Binford, R. D. Holt, C. Stckler, and T. Van Holt. 2005. An exploratory framework for the empirical measurement of resilience. *Ecosystems* 8(8):975–987. http://dx.doi.org/10.1007/s10021-005-0129-z

Darnhofer, I. 2014. Resilience and why it matters for farm management. *European Review of Agricultural Economics* 41(3):461–484. http://dx.doi.org/10.1093/erae/jbu012

Diamantopoulos, A., and J. A. Sigauw. 2006. Formative versus reflective indicators in organizational measure development: a comparison and empirical illustration. *British Journal of Management* 17(4):263–282. http://dx.doi.org/10.1111/j.1467-8551.2006.00500.x

Diamantopoulos, A., and H. M. Winklhofer. 2001. Index construction with formative indicators: an alternative to scale development. *Journal of Marketing Research* 38(2):269–277. http://dx.doi.org/10.1509/jmkr.38.2.269.18845

Diserens, F., J. Choptiany, D. Barjolle, B. Graeub, C. Durand, and J. Six. 2018. Resilience assessment of Swiss farming systems: piloting the SHARP-tool in Vaud. *Sustainability* 10(12):4435. http://dx.doi.org/10.3390/su10124435

Dohmen, T., A. Falk, D. Huffman, U. Sunde, J. Schupp, and G. G. Wagner. 2011. Individual risk attitudes: measurement, determinants, and behavioral consequences. *Journal of the European Economic Association* 9(3):522–550. http://dx.doi.org/10.1111/j.1542-4774.2011.01015.x

Dohmen, T., A. Falk, B. H. H. Golsteyn, D. Huffman, and U. Sunde. 2017. Risk attitudes across the life course. The Economic Journal 127(605):F95–F116. http://dx.doi.org/10.1111/ecoj.12322

Flaten, O., G. Lien, M. Koesling, P. S. Valle, and M. Ebbesvik. 2005. Comparing risk perceptions and risk management in organic and conventional dairy farming: empirical results from Norway. *Livestock Production Science* 95(1–2):11–25. http://dx.doi.org/10.1016/j.livprosci.2004.10.014

Folke, C. 2016. Resilience (Republished). *Ecology and Society* 21(4):44. http://dx.doi.org/10.5751/es-09088-210444

Gardebroek, C. 2006. Comparing risk attitudes of organic and non-organic farmers with a Bayesian random coefficient model. *European Review of Agricultural Economics* 33(4):485–510. http://dx.doi.org/10.1093/erae/bjl029

Ghahramani, A., and D. Bowran. 2018. Transformative and systemic climate change adaptations in mixed crop-livestock farming systems. *Agricultural Systems* 164(4):236–251. http://dx.doi.org/10.1016/j.agsy.2018.04.011

Glover, J. 2012. Rural resilience through continued learning and innovation. *Local Economy* 27(4):355–372. http://dx.doi.org/10.1177/0269094412437833

Greiner, R., and D. Gregg. 2011. Farmers’ intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: empirical evidence from northern Australia. *Land Use Policy* 28(1):257–265. http://dx.doi.org/10.1016/j.landusepol.2010.06.006

Greiner, R., L. Patterson, and O. Miller. 2009. Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems* 99(2–3):86–104. http://dx.doi.org/10.1016/j.agsy.2008.10.003

Grothmann, T., and A. Patt. 2005. Adaptive capacity and human cognition: the process of individual adaptation to climate change. *Global Environmental Change* 15(3):199–213. http://dx.doi.org/10.1016/j.gloenvcha.2005.01.002

Hair, J. F., G. T. M. Hult, C. M. Ringle, and M. Sarstedt. 2016. *A primer on partial least squares structural equation modeling (PLS-SEM).* SAGE Publications, London, UK.

Hair, J. F., L. M. Matthews, R. L. Matthews, and M. Sarstedt. 2017. PLS-SEM or CB-SEM: updated guidelines on which method to use. *International Journal of Multivariate Data Analysis* 1(2):107–123. http://dx.doi.org/10.1504/ijmda.2017.087624

Hair, J. F., M. Sarstedt, C. M. Ringle, and S. P. Gudergan. 2018. *Advanced Issues in partial least squares structural equation modeling.* SAGE Publications, London, UK.

Hardaker, J. B., G. Lien, J. R. Anderson, and R. B. M. Huirne. 2015. *Coping with risk in agriculture: applied decision analysis.* CABI, Wallingford, UK. https://dx.doi.org/10.1079/9781780657420.0000

Henseler, J. R., C. M. Ringle, and M. Sarstedt. 2016. Testing measurement invariance of composites using partial least squares. *International Marketing Review* 33(3):405–431. http://dx.doi.org/10.1108/IMR-09-2014-0304

Holling, C. S. 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* 4(1):1–23. http://dx.doi.org/10.1146/annurev.es.04.110173.000245

Hunecke, C., A. Engler, R. Jara-Rojas, and P. M. Poortvliet. 2017. Understanding the role of social capital in adoption decisions: an application to irrigation technology. *Agricultural Systems* 153(2):221–231. http://dx.doi.org/10.1016/j.agsy.2017.02.002

Iyer, P., M. Bozzola, S. Hirsch, M. Meraner, and R. Finger. 2019. Measuring farmer risk preferences in Europe: a systematic review. *Journal of Agricultural Economics* 71(1):3–26. http://dx.doi.org/10.1111/1477-9552.12325

Jones, L., and T. Tanner. 2017. “Subjective resilience”: using perceptions to quantify household resilience to climate extremes and disasters. *Regional Environmental Change* 17(1):229–243. http://dx.doi.org/10.1007/s10113-016-0995-2

Keil, M., L. Wallace, D. Turk, G. Dixon-Randall, and U. Nulden. 2000. Investigation of risk perception and risk propensity on the...
decision to continue a software development project. *Journal of Systems and Software* 53(2):145–157. https://doi.org/10.1016/S0164-1212(00)00010-8

Marshall, N. A., A.-M. Dowd, A. Fleming, C. Gambley, M. Howden, E. Jakku, C. Larsen, P. A. Marshall, K. Moon, S. Park, and P. J. Thorburn. 2014. Transformational capacity in Australian peanut farmers for better climate adaptation. *Agronomy for Sustainable Development* 34(3):583–591. http://dx.doi.org/10.1007/s11359-013-0186-1

Marshall, N. A., I. J. Gordon, and A. J. Ash. 2011. The reluctance of resource-users to adopt seasonal climate forecasts to enhance resilience to climate variability on the rangelands. *Climatic Change* 107(3–4): 511–529. http://dx.doi.org/10.1007/s10584-010-9962-x

Marshall, N. A., and P. A. Marshall. 2007. Conceptualizing and operationalizing social resilience within commercial fisheries in Northern Australia. *Ecology and Society* 12(1):1. https://doi.org/10.5751/ES-01940-120101

Marshall, N. A., and A. Smajgl. 2013. Understanding variability in adaptive capacity on rangelands. *Rangeland Ecology and Management* 66(1):88–94. http://dx.doi.org/10.2111/REM-D-11-00176.1

Marshall, N. A., and C. J. Stokes. 2014. Influencing adaptation processes on the Australian rangelands for social and ecological resilience. *Ecology and Society* 19(2):14. http://dx.doi.org/10.5751/ES-06440-190214

Meraner, M., and R. Finger. 2019. Risk perceptions, preferences and management strategies: evidence from a case study using German livestock farmers. *Journal of Risk Research* 22(1):110–135. http://dx.doi.org/10.1080/13669877.2017.1351476

Meeussen, M. P. M., P. H. Feindt, A. Spiegel, C. J. A. M. Termeer, E. Mathijs, Y. de Mey, R. Finger, A. Balmaen, E. Wauters, J. Urquhart, M. Vigan, K. Zawalinski, H. Herrera, P. Nicholas-Davies, H. Hansson, W. Paas, T. Sliper, I. Coopmans, W. Vroeger, A. Ciechomska, F. Accatino, B. Kopainsky, P. M. Poortvliet, J. J. Meraner, M., D. Maye, S. Severini, S. Senni, B. Soriano, C.-J. Lagerkvist, M. Peneva, C. Gavrilescu, and P. Reidsma. 2019. A framework to assess the resilience of farming systems. *Agricultural Systems* 176(1):102656. http://dx.doi.org/10.1016/j.agsy.2019.102656

Meeussen, M. P. M., R. B. M. Huirne, and J. B. Hardaker. 2001. Risk and risk management: an empirical analysis of Dutch livestock farmers. *Livestock Production Science* 69(1):43–53. http://dx.doi.org/10.1016/s0301-6226(00)00247-5

Netemeyer, R. W., W. Bearden, and S. Sharma. 2003. *Scaling procedures: issues and applications*. Sage Publications, Thousand Oaks, California, USA.

Ohlund, E., K. Zurek, and M. Hammer. 2015. Towards sustainable agriculture? The EU framework and local adaptation in Sweden and Poland. *Environmental Policy and Governance* 25(4):270–287. http://dx.doi.org/10.1002/epg.1687

Onwuegbuzie, A. J., A. E. Witcher, K. M. T. Collins, J. D. Filer, C. D. Wiedmaier, and C. W. Moore. 2016. Students’ perceptions of characteristics of effective college teachers: a validity study of a teaching evaluation form using a mixed-methods analysis.

*American Educational Research Journal* 44(1):113–160. http://dx.doi.org/10.3102/0001831206298169

Park, J., T. P. Seager, P. S. Rao, M. Convertino, and I. Linkov. 2013. Integrating risk and resilience approaches to catastrophe management in engineering systems. *Risk Analysis* 33(3):356–367. http://dx.doi.org/10.1111/j.1539-6924.2012.01885.x

Peerlings, J., N. Polman, and L. Dries. 2014. Self-reported resilience of European farmers with and without the CAP. *Journal of Agricultural Economics* 65(3):722–738. http://dx.doi.org/10.1111/1477-9552.12062

Pelling, M. 2011. *Adaptation to climate change: from resilience to transformation*. Routledge Taylor & Francis Group, London, UK. https://dx.doi.org/10.4324/9780203889046

Resilience Alliance. 2010. *Assessing resilience in social–ecological systems: workbook for practitioners*. Resilience Alliance, Stockholm, Sweden. [online] URL: https://www.researchgate.net/publication/284030932_Assessing_Resilience_in_Social-Ecological_Systems_Workbook_for_Practitioners_Version_2

Reynaud, A., and S. Couture. 2012. Stability of risk preference measures: results from a field experiment on French farmers. *Theory and Decision* 73(2):203–221. http://dx.doi.org/10.1007/s11238-012-9296-5

Ringle, C. M., S. Wende, and J.-M. Becker. 2015. *SmartPLS 3*. SmartPLS, Böningenstadt, Germany.

Saint-Cyr, L. D. F., H. Storm, T. Heckelei, and L. Piet. 2019. Heterogeneous impacts of neighbouring farm size on the decision to exit: evidence from Brittany. *European Review of Agricultural Economics* 46(2):237–266. http://dx.doi.org/10.1093/ereae/jbx029

Sarstedt, M., C. M. Ringle, and J. F. Hair. 2017. Partial least squares structural equation modeling. Pages 1–40 in C. Homburg, M. Klarmann, and A. Vomberg, editors. *Handbook of Market Research*. Springer Nature, Basel, Switzerland. https://doi.org/10.1007/978-3-319-05542-8_15-1

Schmit, J. T., and K. Roth. 1990. Cost effectiveness of risk management practices. *The Journal of Risk and Insurance* 57(3):455–470. http://dx.doi.org/10.1111/j.1539-6924.1990.tb00703.x

Scholz, R. W., Y. B. Blumer, and F. S. Brand. 2012. Risk, vulnerability, robustness, and resilience from a decision-theoretic perspective. *Journal of Risk Research* 15(3):313–330. http://dx.doi.org/10.1080/13669877.2011.634522

Stone, J., and S. Rahimifard. 2018. Resilience in agri-food supply chains: a critical analysis of the literature and synthesis of a novel framework. *Supply Chain Management: An International Journal* 23(3):207–238. http://dx.doi.org/10.1108/scm-06-2017-0201

Sutherland, L.-A., J. Hopkins, L. Toma, A. Barnes, and K. Matthews. 2017. Adaptation, resilience and CAP reform: a comparison of crofts and livestock farms in Scotland. *Scottish Geographical Journal* 133(3):192–213. http://dx.doi.org/10.1080/14702541.2017.1353703

van Latesteijn, editor. *Operationalizing social resilience within commercial fisheries in northern Australia*. Routledge, London. https://www.ecologyandsociety.org/vol25/iss4/art10/
Termeer, C. J. A. M., P. H. Feindt, T. Karpouzoglou, K. J. Poppe, G. J. Hofstede, K. Kramer, L. Ge, E. Mathijs, and M. P. M. Meuwissen. 2019. Institutions and the resilience of biobased production systems: the historical case of livestock intensification in the Netherlands. *Ecology and Society* 24(4):15. http://dx.doi.org/10.5751/es-11206-240415

Tong, Y., H. Niu, and L. Fan. 2016. Willingness of farmers to transform vacant rural residential land into cultivated land in a major grain-producing area of central China. *Sustainability* 8(11):1192. http://dx.doi.org/10.3390/su8111192

van der Linden, S. 2015. The social–psychological determinants of climate change risk perceptions: towards a comprehensive model. *Journal of Environmental Psychology* 41(1):112–124. http://dx.doi.org/10.1016/j.jenvp.2014.11.012

van Winsen, F., Y. de Mey, L. Lauwers, S. van Passel, M. Vangrunderbeek, and E. Wauters. 2016. Determinants of risk behaviour: effects of perceived risks and risk attitude on farmers–adopters' adoption of risk management strategies. *Journal of Risk Research* 19(1):56–78. http://dx.doi.org/10.1080/13669877.2014.940597

Vigani, M., and J. Kathage. 2019. To risk or not to risk? Risk management and farm productivity. *American Journal of Agricultural Economics* 101(5):1432–1454. http://dx.doi.org/10.1093/ajae/aaz020

Walker, B., N. H. Abel, J. M. Anderies, and P. Ryan. 2009. Resilience, adaptability, and transformability in the Goulburn-Broken Catchment, Australia. *Ecology and Society* 14(1):12. http://www.ecologyandsociety.org/vol14/iss1/art12/ https://doi.org/10.5751/ES-02824-140112

Walker, B., C. S. Holling, S. R. Carpenter, and A. Kinzig. 2004. Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society* 9(2):5. https://doi.org/10.5751/ES-00650-090205
### Appendix

**Table A1.1 Overview of risk management strategies included in the survey**

| Flexibility of farm activities | Cooperation with others | Financial risk management | Measures to control environmental risks | Specialization | Diversification | Learning |
|-------------------------------|-------------------------|---------------------------|----------------------------------------|----------------|----------------|----------|
| Improved cost flexibility     | Had access to a variety of input suppliers | Bought any type of agricultural insurance | Invested in technologies | Specialization | Diversified in production | Opened up my farm to the public |
| Improved flexibility in the timing of my production | Member of an (inter)branch organization | Used production or marketing contracts to sell (part of) my production | Implemented measures to prevent pests or diseases | | Diversified in other activities on my farm | |
| Worked harder to secure production in hard times | Member of a producer organization, cooperative or credit union | Hedged (part of) my production with futures contracts | Had an off-farm job | | | Used market information to plan my farm activities for the next season |
| | Cooperated with other farmers to secure inputs or production | Maintained financial savings for hard times | | | | Learned about challenges in agriculture |
| | | Had low debts or no debts at all to prevent financial risks | | | | Experimenting with precision agriculture, smart farming or drones. |
| Outer loadings | Cronbach's alpha | Composite reliability | AVE | VIF |
|----------------|------------------|-----------------------|-----|-----|
| ADAP           | All Low High     | All Low High          | All Low High | All Low High |
| adap_1         | 0.715 0.711 0.718 | 0.760 0.782 0.746    | 0.848 0.859 0.840 | 0.589 0.610 0.575 |
| adap_2         | 0.875 0.881 0.874 |                      |                  | 1.758 2.010 1.640 |
| adap_3         | 0.870 0.894 0.856 |                      |                  |                  |
| adap_4         | 0.566 0.600 0.538 |                      |                  |                  |
| INNO           | All Low High     | 0.856 0.851 0.858    | 0.932 0.930 0.933 | 0.873 0.869 0.875 |
| inno_1         | 0.944 0.948 0.941 |                      |                  | 1.620 1.652 1.586 |
| inno_2         | 0.925 0.916 0.930 |                      |                  |                  |
| NET INF        | All Low High     | 0.774 0.792 0.765    | 0.869 0.877 0.862 | 0.689 0.706 0.675 |
| net_1          | 0.808 0.846 0.788 |                      |                  | 1.527 1.391 1.636 |
| net_2          | 0.891 0.933 0.858 |                      |                  |                  |
| net_3          | 0.786 0.731 0.818 |                      |                  |                  |
| NET FOR        | All Low High     | 0.813 0.768 0.831    | 0.888 0.866 0.897 | 0.726 0.684 0.744 |
| net_4          | 0.838 0.853 0.833 |                      |                  | 1.777 1.646 1.879 |
| net_5          | 0.864 0.852 0.870 |                      |                  |                  |
| net_6          | 0.854 0.774 0.884 |                      |                  |                  |
| PBC            | All Low High     | 0.646 0.648 0.643    | 0.792 0.794 0.789 | 0.495 0.506 0.488 |
| pbc_1          | 0.827 0.837 0.829 |                      |                  | 1.406 1.415 1.404 |
| pbc_2          | 0.695 0.746 0.658 |                      |                  |                  |
| pbc_3          | 0.743 0.780 0.722 |                      |                  |                  |
| pbc_4          | 0.510 0.398 0.557 |                      |                  |                  |
| ROB            | All Low High     | 0.576 0.520 0.599    | 0.762 0.717 0.775 | 0.484 0.476 0.487 |
| rob_1          | 0.792 0.796 0.779 |                      |                  | 1.323 1.340 1.309 |
| rob_2          | 0.180 -0.083 0.294 |                      |                  |                  |
| rob_3          | 0.771 0.797 0.752 |                      |                  |                  |
| rob_4          | 0.827 0.792 0.831 |                      |                  |                  |
| TRANS          | All Low High     | 0.715 0.725 0.703    | 0.828 0.830 0.823 | 0.582 0.593 0.572 |
| trans_1        | 0.840 0.881 0.811 |                      |                  | 1.705 2.071 1.554 |
| trans_2        | 0.227 0.173 0.240 |                      |                  |                  |
| trans_3        | 0.880 0.867 0.886 |                      |                  |                  |
| trans_4        | 0.894 0.903 0.886 |                      |                  |                  |
Table A1. HTMT confidence intervals (reduced model)

|        | ADAP      | INNO      | NET FOR    | NET INF    | PBC       | RM        | ROB       |
|--------|-----------|-----------|------------|------------|-----------|-----------|-----------|
| INNO   |           |           |            |            |           |           |           |
| All    | [0.387; 0.535] | [0.383; 0.568] | [0.303; 0.479] | [0.185; 0.366] | [0.572; 0.717] | [0.127; 0.274] | [0.490; 0.642]  |
| Low    | [0.300; 0.536] | [0.326; 0.595] | [0.326; 0.595] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| High   | [0.303; 0.479] | [0.355; 0.527] | [0.330; 0.604] | [0.355; 0.527] | [0.239; 0.371] | [0.387; 0.605] | [0.190; 0.373]  |
| NET FOR| All        | [0.300; 0.536] | [0.326; 0.595] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| Low    | [0.300; 0.536] | [0.241; 0.503] | [0.241; 0.503] | [0.326; 0.595] | [0.239; 0.371] | [0.387; 0.605] | [0.190; 0.373]  |
| High   | [0.303; 0.479] | [0.260; 0.447] | [0.330; 0.604] | [0.355; 0.527] | [0.239; 0.371] | [0.387; 0.605] | [0.190; 0.373]  |
| NET INF| All        | [0.303; 0.479] | [0.326; 0.595] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| Low    | [0.174; 0.421] | [0.062; 0.312] | [0.062; 0.312] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| High   | [0.151; 0.368] | [0.549; 0.767] | [0.151; 0.368] | [0.151; 0.368] | [0.549; 0.767] | [0.151; 0.368] | [0.151; 0.368]  |
| PBC    | All        | [0.303; 0.479] | [0.326; 0.595] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| Low    | [0.514; 0.764] | [0.343; 0.605] | [0.343; 0.605] | [0.343; 0.605] | [0.343; 0.605] | [0.343; 0.605] | [0.343; 0.605]  |
| High   | [0.545; 0.735] | [0.168; 0.470] | [0.168; 0.470] | [0.168; 0.470] | [0.168; 0.470] | [0.168; 0.470] | [0.168; 0.470]  |
| RM     | All        | [0.303; 0.479] | [0.326; 0.595] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| Low    | [0.112; 0.349] | [0.241; 0.461] | [0.241; 0.461] | [0.241; 0.461] | [0.241; 0.461] | [0.241; 0.461] | [0.241; 0.461]  |
| High   | [0.092; 0.280] | [0.102; 0.278] | [0.102; 0.278] | [0.102; 0.278] | [0.102; 0.278] | [0.102; 0.278] | [0.102; 0.278]  |
| ROB    | All        | [0.303; 0.479] | [0.326; 0.595] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| Low    | [0.438; 0.713] | [0.088; 0.337] | [0.088; 0.337] | [0.088; 0.337] | [0.088; 0.337] | [0.088; 0.337] | [0.088; 0.337]  |
| High   | [0.458; 0.649] | [0.443; 0.657] | [0.443; 0.657] | [0.443; 0.657] | [0.443; 0.657] | [0.443; 0.657] | [0.443; 0.657]  |
| TRANS  | All        | [0.303; 0.479] | [0.326; 0.595] | [0.154; 0.328] | [0.405; 0.577] | [0.197; 0.326] | [0.132; 0.306]  |
| Low    | [0.766; 0.893] | [0.113; 0.368] | [0.113; 0.368] | [0.113; 0.368] | [0.113; 0.368] | [0.113; 0.368] | [0.113; 0.368]  |
| High   | [0.617; 0.786] | [0.205; 0.249] | [0.205; 0.249] | [0.205; 0.249] | [0.205; 0.249] | [0.205; 0.249] | [0.205; 0.249]  |

Notes: The numbers in squared brackets present the 95% bias-corrected and accelerated confidence interval of the HTMT statistics. 4,000 bootstrapping samples were used with the no sign changes option.
### Table A1.4 Formative item validity assessment (reduced model)

| Outer weight | St dev | Outer weight | St dev | Outer weight | St dev | Outer loadings | VIF |
|--------------|--------|--------------|--------|--------------|--------|----------------|-----|
| **RM**       |        |              |        |              |        |                |     |
| All          | All    | Low          | Low    | High         | High   | All            |     |
| 1.410        | 1.160  | 1.142        |        |              |        |                |     |
| **RISK PREF**|        |              |        |              |        |                |     |
| riskpref_1   | -0.021 | 0.086        | -0.035 | 0.161        | -0.024 | 0.118          |     |
| riskpref_2   | 0.561***0.076 | 0.537***0.115 | 0.609***0.094 | 0.845 0.824 0.867 | 1.349 1.331 1.356 | 1.638 1.742 1.588 |
| riskpref_3   | 0.462***0.090 | 0.474***0.152 | 0.470***0.116 | 0.814 0.826 0.799 | 1.872 1.937 1.832 | 1.731 1.772 1.715 |
| riskpref_4   | 0.220**0.097 | 0.251*0.147  | 0.157 0.116 | 0.737 0.750 0.701 | 1.731 1.772 1.715 | 1.100 1.121 1.117 |
| **RISK PERC**|        |              |        |              |        |                |     |
| riskperc_1   | 0.460***0.069 | 0.422***0.152 | 0.462***0.079 | 0.865 0.850 0.865 | 1.650 1.664 1.643 | 1.637 1.449 1.637 |
| riskperc_2   | 0.645***0.063 | 0.679***0.136 | 0.644***0.072 | 0.934 0.945 0.933 | 1.650 1.664 1.643 | 1.581 1.837 1.581 |
| riskperc_3   | 0.574***0.057 | 0.546***0.104 | 0.570***0.074 | 0.856 0.856 0.847 | 1.631 1.769 1.608 | 1.743 1.735 1.743 |
| riskperc_4   | 0.589***0.056 | 0.603***0.101 | 0.599***0.071 | 0.864 0.884 0.863 | 1.683 1.779 1.729 | 1.100 1.121 1.117 |
| riskperc_5   | 0.632***0.045 | 0.710***0.079 | 0.611***0.057 | 0.894 0.938 0.877 | 1.665 1.946 1.719 | 1.388 1.367 1.388 |
| riskperc_6   | 0.519***0.049 | 0.415***0.093 | 0.549***0.059 | 0.838 0.806 0.846 | 1.775 1.838 1.654 | 1.236 1.330 1.236 |
| riskperc_7   | 0.708***0.056 | 0.787***0.093 | 0.690***0.073 | 0.900 0.928 0.899 | 1.411 1.385 1.462 | 1.461 1.321 1.419 |
| riskperc_8   | 0.477***0.066 | 0.398***0.125 | 0.486***0.085 | 0.761 0.678 0.782 | 1.566 1.321 1.419 | 1.388 1.367 1.388 |
| riskperc_9   | 0.483***0.083 | 0.480***0.156 | 0.496***0.131 | 0.824 0.810 0.837 | 1.510 1.539 1.531 | 1.236 1.330 1.236 |
| riskperc_10  | 0.661***0.075 | 0.673***0.139 | 0.645***0.119 | 0.910 0.908 0.907 | 1.566 1.562 1.674 | 1.236 1.330 1.236 |
| riskperc_11  | 0.710***0.122 | 0.873          |        |              |        |                |     |
| riskperc_12  | 0.515***0.135 | 0.739          |        |              |        |                |     |
| riskperc_13  | 0.721***0.053 | 0.745***0.083 | 0.677***0.069 | 0.897 0.919 0.861 | 1.460 1.710 1.376 | 1.466 1.579 1.466 |
| Risk Perception Items | Outer Weights | Outer Loadings |
|-----------------------|---------------|----------------|
| riskperc_15           | 0.476***      | 0.064          |
| Risk Perc            | 0.430***      | 0.105          |
| RISK Perc_8           | 0.540***      | 0.076          |
| riskperc_16           | 1.456         | 1.684          |
| riskperc_17           | 1.402         | 1.348          |
| res_1                 | 0.591***      | 0.079          |
| RES                   | 0.442***      | 0.149          |
| res_2                 | 0.670***      | 0.096          |
|                      | 0.935         | 0.898          |
|                      | 0.953         | 1.938          |
|                      | 2.080         | 1.873          |
|                      | 1.938         | 2.080          |
|                      | 1.873         |                |

Notes: outer weights and outer loadings of the risk perceptions items loading on the second order construct RISK PERC have been omitted for brevity. * p≤0.10; ** p≤0.05; *** p≤0.01
Table A1.1. $R^2$ and $Q^2$ values of the structural model

|        | All   | Low   | High  | All   | Low   | High  |
|--------|-------|-------|-------|-------|-------|-------|
| **ADAP** | 0.334 | 0.365 | 0.327 | 0.219 | 0.230 | 0.210 |
| **PBC**  | 0.012 | 0.030 | 0.006 | 0.006 | 0.016 | 0.002 |
| **RES**  | 0.250 | 0.288 | 0.233 | 0.198 | 0.226 | 0.178 |
| **RISK PERC** | 1.000 | 1.000 | 1.000 | 0.292 | 0.330 | 0.312 |
| **RISK PREF** | 0.056 | 0.051 | 0.064 | 0.026 | 0.024 | 0.027 |
| **ROB**  | 0.186 | 0.193 | 0.194 | 0.110 | 0.098 | 0.113 |
| **TRANS** | 0.282 | 0.300 | 0.271 | 0.202 | 0.197 | 0.188 |
Table A1.6. $f^2$ statistics of the structural model

|       | ADAP | PBC  | RES  | RISK PREF | ROB  | TRANS |
|-------|------|------|------|-----------|------|-------|
| ADAP  | All  | 0.041|      |           |      |       |
| ADAP  | Low  | 0.056|      |           |      |       |
| ADAP  | High | 0.032|      |           |      |       |
| INNO  | All  | 0.010| 0.001| 0.000     |      |       |
| INNO  | Low  | 0.003| 0.005| 0.002     |      |       |
| INNO  | High | 0.016| 0.001| 0.002     |      |       |
| NET FOR| All  | 0.004|      |           |      |       |
| NET FOR| Low  | 0.018| 0.000| 0.003     |      |       |
| NET FOR| High | 0.001|      |           |      |       |
| NET INF| All  | 0.001|      |           |      |       |
| NET INF| Low  | 0.004| 0.004| 0.003     |      |       |
| PBC   | All  | 0.152| 0.112| 0.152     |      |       |
| PBC   | Low  | 0.169| 0.113| 0.183     |      |       |
| PBC   | High | 0.140| 0.112| 0.136     |      |       |
| RISK PERC| All  | 0.001| 0.011| 0.003     |      |       |
| RISK PERC| Low  | 0.000| 0.000| 0.004     |      |       |
| RISK PERC| High | 0.005| 0.022| 0.002     |      |       |
| RISK PREF| All  | 0.024| 0.007| 0.041     |      |       |
| RISK PREF| Low  | 0.019| 0.032| 0.036     |      |       |
| RISK PREF| High | 0.026| 0.001| 0.041     |      |       |
| RM    | All  | 0.004| 0.012| 0.060     | 0.000| 0.001|
| RM    | Low  | 0.003| 0.031| 0.053     | 0.002| 0.000|
| RM    | High | 0.004| 0.006| 0.068     | 0.000| 0.002|
| ROB   | All  | 0.073|      |           |      |       |
| ROB   | Low  | 0.063|      |           |      |       |
| ROB   | High | 0.085|      |           |      |       |
| TRANS | All  | 0.010|      |           |      |       |
| TRANS | Low  | 0.009|      |           |      |       |
| TRANS | High | 0.010|      |           |      |       |
Table A1.7. $q^2$ statistics of the structural model

|               | ADAP | RES | ROB | TRANS |
|---------------|------|-----|-----|-------|
| ADAP All      | 0.030|     |     |       |
| ADAP Low      | 0.005|     |     |       |
| ADAP High     | 0.005|     |     |       |
| INNO All      | 0.005| 0.000| -0.001|       |
| INNO Low      | -0.015| 0.015| -0.007|       |
| INNO High     | 0.020| -0.005| 0.017|       |
| NET FOR All   | 0.001| 0.002| 0.002|       |
| NET FOR Low   | -0.010| 0.012| 0.006|       |
| NET FOR High  | 0.012| 0.003| 0.019|       |
| NET INF All   | 0.000| -0.001| 0.000|       |
| NET INF Low   | -0.013| 0.013| 0.005|       |
| NET INF High  | 0.012| -0.004| 0.018|       |
| PBC All       | 0.085| 0.062| 0.099|       |
| PBC Low       | 0.086| 0.079| 0.130|       |
| PBC High      | 0.092| 0.058| 0.106|       |
| RISK PERC All | 0.000| 0.006| 0.002|       |
| RISK PERC Low | -0.022| 0.004| 0.003|       |
| RISK PERC High| 0.014| 0.008| 0.019|       |
| RISK PREF All | 0.013| 0.003| 0.026|       |
| RISK PREF Low | -0.007| 0.029| 0.022|       |
| RISK PREF High| 0.025| -0.006| 0.043|       |
| RM All        | 0.003| 0.000| 0.000|       |
| RM Low        | -0.015| 0.011| 0.001|       |
| RM High       | 0.014| -0.005| 0.017|       |
| ROB All       | 0.052|     |     |       |
| ROB Low       | 0.008|     |     |       |
| ROB High      | 0.081|     |     |       |
| TRANS All     | 0.007|     |     |       |
| TRANS Low     | -0.032|     |     |       |
| TRANS High    | 0.033|     |     |       |
### Table A1.8. Compositional invariance assessment

|       | Original Correlation | 5.0% | Permutation p-Values |
|-------|----------------------|------|----------------------|
| **ADAP** | 0.999                | 0.998| 0.309                |
| **INNO** | 1.000                | 0.998| 0.487                |
| **NET FOR** | 0.997                | 0.994| 0.182                |
| **NET INF** | 0.986                | 0.968| 0.209                |
| **PBC** | 1.000                | 0.996| 0.787                |
| **RES** | 0.985                | 0.967| 0.180                |
| **RISK PERC** | 0.990                | 0.990| 0.067                |
| **RISK PERC_1** | 0.999                | 0.973| 0.710                |
| **RISK PERC_2** | 1.000                | 0.973| 0.966                |
| **RISK PERC_3** | 0.985                | 0.984| 0.062                |
| **RISK PERC_4** | 0.994                | 0.963| 0.437                |
| **RISK PERC_5** | 1.000                | 0.951| 0.886                |
| **RISK PERC_6** | 0.801                | 0.820| 0.040**              |
| **RISK PERC_7** | 0.987                | 0.963| 0.241                |
| **RISK PERC_8** | 1.000                | 0.964| 0.847                |
| **RISK PREF** | 0.994                | 0.917| 0.910                |
| **RM** | 1.000                | 1.000| 0.405                |
| **ROB** | 0.998                | 0.994| 0.314                |
| **TRANS** | 0.999                | 0.999| 0.060                |

Notes: * p ≤ 0.10; ** p ≤ 0.05; *** p ≤ 0.01.
**Table A1.9. Equal means and variance assessments**

| Variable   | Mean - Original Difference | Mean - Permutation Mean Difference | Permutation p-Values | Variance - Original Difference | Variance - Permutation Mean Difference | Permutation p-Values |
|------------|----------------------------|-----------------------------------|----------------------|--------------------------------|----------------------------------------|----------------------|
| ADAP       | 0.079                      | 0.000                            | 0.257                | 0.076                          | -0.001                                 | 0.413                |
| INNO       | 0.189                      | 0.002                            | 0.004***             | -0.008                         | -0.001                                 | 0.925                |
| NET FOR    | 0.146                      | 0.000                            | 0.032**              | -0.277                         | -0.003                                 | 0.003***             |
| NET INF    | 0.021                      | 0.000                            | 0.757                | 0.089                          | -0.005                                 | 0.382                |
| PBC        | 0.169                      | 0.001                            | 0.011**              | 0.052                          | -0.002                                 | 0.590                |
| RES        | 0.092                      | 0.000                            | 0.179                | -0.004                         | -0.001                                 | 0.968                |
| RISK PERC  | -0.166                     | 0.001                            | 0.017**              | 0.010                          | -0.001                                 | 0.938                |
| RISK PERC_1| -0.029                     | 0.001                            | 0.665                | -0.099                         | -0.001                                 | 0.297                |
| RISK PERC_2| -0.134                     | 0.000                            | 0.051*               | 0.015                          | -0.002                                 | 0.872                |
| RISK PERC_3| -0.130                     | 0.001                            | 0.059*               | 0.012                          | -0.003                                 | 0.902                |
| RISK PERC_4| -0.076                     | 0.001                            | 0.260                | -0.129                         | -0.001                                 | 0.108                |
| RISK PERC_5| -0.019                     | 0.003                            | 0.787                | -0.049                         | -0.001                                 | 0.589                |
| RISK PERC_7| -0.236                     | -0.001                           | 0.001***             | 0.130                          | -0.003                                 | 0.207                |
| RISK PERC_8| -0.121                     | 0.000                            | 0.084                | -0.088                         | -0.002                                 | 0.314                |
| RISK PREF  | 0.225                      | 0.002                            | 0.001***             | -0.110                         | -0.004                                 | 0.266                |
| RM         | -0.056                     | 0.000                            | 0.416                | 0.017                          | -0.002                                 | 0.834                |
| ROB        | 0.185                      | 0.001                            | 0.009***             | -0.204                         | -0.006                                 | 0.039**              |
| TRANS      | 0.260                      | 0.002                            | 0.001***             | 0.088                          | -0.004                                 | 0.293                |

Notes: * p ≤ 0.10; ** p ≤ 0.05; *** p ≤ 0.01.
Table A1.1. Path coefficients including domain-specific risk perceptions of the PLS-SEM. RP FIN = risk perception in the financial domain, RP INST = risk perception in the institutional domain, RP PERS = risk perception in the personal and personnel domain, RP INPUT = risk perception in the input price domain, RP MARKET = risk perception in the market price domain, RP PROD = risk perception in the production domain, RP SC = risk perception in the supply chain domain, RP SOC = risk perception in the social domain.

| Path Coefficient | Direct effects | Total effects |
|------------------|---------------|---------------|
|                  | All (N = 916) | Low (N = 329) | High (N = 587) | Difference (Low-High) | All (N = 916) | Low (N = 329) | High (N = 587) | Difference (Low-High) |
| Risk behavior    |               |               |               |                     |               |               |               |                     |
| RM → RISK PREF   | 0.237***      | 0.225***      | 0.253***      | -0.027              | 0.237***      | 0.225***      | 0.253***      | -0.027              |
|                  | (0.033)       | (0.055)       | (0.042)       |                      | (0.033)       | (0.055)       | (0.042)       |                      |
| RM → PBC         | 0.109***      | 0.174***      | 0.076*        | 0.098               | 0.109***      | 0.174***      | 0.076*        | 0.098               |
|                  | (0.034)       | (0.055)       | (0.043)       |                      | (0.034)       | (0.055)       | (0.043)       |                      |
| PBC → RISK PERC  | -0.141***     | -0.132        | -0.143***     | 0.011               | -0.141***     | -0.132        | -0.143***     | 0.011               |
|                  | (0.044)       | (0.088)       | (0.051)       |                      | (0.044)       | (0.088)       | (0.051)       |                      |
| PBC → RP FIN     | -0.085**      | -0.189***     | -0.029        | -0.106**            | -0.085**      | -0.189***     | -0.029        | -0.106**            |
|                  | (0.039)       | (0.072)       | (0.046)       |                      | (0.039)       | (0.072)       | (0.046)       |                      |
| PBC → RP INST    | -0.167***     | -0.102        | -0.205***     | 0.102               | -0.167***     | -0.102        | -0.205***     | 0.102               |
|                  | (0.040)       | (0.074)       | (0.045)       |                      | (0.040)       | (0.074)       | (0.045)       |                      |
| PBC → RP PERS    | -0.060        |               |               |                     | -0.060        |               |               |                     |
|                  | (0.047)       |               |               |                      | (0.047)       |               |               |                      |
| PBC → RP INPUT   | -0.027        | 0.020         | -0.049        | 0.069               | -0.027        | 0.020         | -0.049        | 0.069               |
|                  | (0.040)       | (0.074)       | (0.050)       |                      | (0.040)       | (0.074)       | (0.050)       |                      |
| PBC → RP MARKET  | -0.044        | -0.062        | -0.031        | -0.031              | -0.044        | -0.062        | -0.031        | -0.031              |
| Source        | Target         | t-value 1 | t-value 2 | t-value 3 | t-value 4 | t-value 5 | t-value 6 | t-value 7 | t-value 8 | t-value 9 | t-value 10 | t-value 11 |
|---------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| PBC → RP PROD |                | -0.042    | 0.003     | -0.067    | 0.070     | -0.042    | 0.003     | -0.067    | 0.070     | -0.042    | 0.003     | -0.067    | 0.070     |
| PBC → RP SC   |                | -0.149*** | -0.186**  | -0.125*** | -0.060    | -0.149*** | -0.186**  | -0.125*** | -0.060    | -0.149*** | -0.186**  | -0.125*** | -0.060    |
| PBC → RP SOC  |                | -0.139*** | -0.115    | -0.158*** | 0.042     | -0.139*** | -0.115    | -0.158*** | 0.042     | -0.139*** | -0.115    | -0.158*** | 0.042     |
| RISK PREF → RISK PERC |         | 0.082*    | 0.209***  | -0.007    | 0.217**   | 0.082*    | 0.209***  | -0.007    | 0.217**   | 0.082*    | 0.209***  | -0.007    | 0.217**   |
| RISK PREF → RP FIN |           | 0.114***  | 0.274***  | 0.040     | 0.234***  | 0.114***  | 0.274***  | 0.040     | 0.234***  | 0.114***  | 0.274***  | 0.040     | 0.234***  |
| RISK PREF → RP INST |          | -0.028    | 0.024     | -0.044    | 0.068     | -0.028    | 0.024     | -0.044    | 0.068     | -0.028    | 0.024     | -0.044    | 0.068     |
| RISK PREF → RP PERS |          | 0.154***  | 0.154***  |          |          |          |          |          |          |          |          |          |          |
| RISK PREF → RP INPUT |         | 0.072*    | 0.125*    | 0.041     | 0.084     | 0.072*    | 0.125*    | 0.041     | 0.084     | 0.072*    | 0.125*    | 0.041     | 0.084     |
| RISK PREF → RP MARKET |        | 0.008     | 0.163**   | -0.068    | 0.231**   | 0.008     | 0.163**   | -0.068    | 0.231**   | 0.008     | 0.163**   | -0.068    | 0.231**   |
| RISK PREF → RP PROD |          | 0.027     | 0.068     | 0.001     | 0.067     | 0.027     | 0.068     | 0.001     | 0.067     | 0.027     | 0.068     | 0.001     | 0.067     |
| Source          | Target          | Coefficient 1  | Coefficient 2  | Coefficient 3  | Coefficient 4  | Coefficient 5  | Coefficient 6  | Coefficient 7  | Coefficient 8  |
|-----------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| RISK PREF → RP SC |                 | 0.104**        | 0.227***       | 0.182**        | 0.104**        | 0.227***       | 0.182**        | 0.104**        | 0.227***       |
|                 |                 | (0.041)        | (0.070)        | (0.055)        | (0.041)        | (0.070)        | (0.055)        | (0.041)        | (0.070)        |
|                  | RISK PREF → RP SOC | -0.005         | 0.121          | -0.059         | 0.180**        | -0.005         | 0.121          | -0.059         | 0.180**        |
|                 |                 | (0.043)        | (0.076)        | (0.052)        | (0.043)        | (0.076)        | (0.052)        | (0.043)        | (0.076)        |
| RM → RISK PERC  |                 | 0.162***       | 0.145**        | 0.149***       | -0.004         | 0.162***       | 0.145**        | 0.149***       | -0.004         |
|                 |                 | (0.036)        | (0.060)        | (0.045)        | (0.036)        | (0.060)        | (0.045)        | (0.036)        | (0.060)        |
| RM → RP FIN     |                 | 0.049          | -0.047         | 0.104**        | -0.151**       | 0.067*         | -0.019         | 0.112**        | -0.131*        |
|                 |                 | (0.034)        | (0.053)        | (0.045)        | (0.034)        | (0.055)        | (0.045)        | (0.034)        | (0.055)        |
| RM → RP INST    |                 | 0.117***       | 0.144**        | 0.088**        | 0.056          | 0.093***       | 0.131**        | 0.062          | 0.070          |
|                 |                 | (0.034)        | (0.059)        | (0.040)        | (0.035)        | (0.058)        | (0.042)        | (0.035)        | (0.058)        |
| RM → RP PERS    |                 | 0.120***       |                |                |                |                |                |                |                |
|                 |                 | (0.038)        |                |                |                |                |                |                |                |
| RM → RP INPUT   |                 | 0.065*         | 0.019          | 0.088**        | -0.069         | 0.079**        | 0.051          | 0.095**        | -0.044         |
|                 |                 | (0.034)        | (0.059)        | (0.042)        | (0.034)        | (0.059)        | (0.042)        | (0.034)        | (0.059)        |
| RM → RP MARKET  |                 | 0.129***       | 0.093          | 0.147***       | -0.054         | 0.126***       | 0.119**        | 0.128***       | -0.009         |
|                 |                 | (0.034)        | (0.057)        | (0.041)        | (0.034)        | (0.059)        | (0.042)        | (0.034)        | (0.059)        |
| RM → RP PROD    |                 | 0.151***       | 0.164***       | 0.142***       | 0.021          | 0.153***       | 0.179***       | 0.138***       | 0.042          |
|                 |                 | (0.034)        | (0.057)        | (0.043)        | (0.034)        | (0.056)        | (0.043)        | (0.034)        | (0.056)        |
| RM → RP SC      |                 | 0.129***       | 0.090          | 0.149***       | -0.059         | 0.138***       | 0.109**        | 0.151***       | -0.042         |
|                 |                 | (0.034)        | (0.057)        | (0.043)        | (0.034)        | (0.056)        | (0.043)        | (0.034)        | (0.056)        |
| Source                | Relationship | RM → RP SOC | RP FIN → RISK PERC | RP INST → RISK PERC | RP PERS → RISK PERC | RP INPUT → RISK PERC | RP MARKET → RISK PERC | RP PROD → RISK PERC | RP SC → RISK PERC | RP SOC → RISK PERC |
|----------------------|--------------|-------------|--------------------|--------------------|---------------------|---------------------|----------------------|---------------------|-------------------|-------------------|
|                      |              | (0.034)     | (0.055)            | (0.044)            |                     | (0.034)            | (0.055)             | (0.044)            |                   |                   |
| RM → RP SOC          |              | 0.061*      | 0.094*             | 0.038              | 0.056              | 0.044              | 0.101*              | 0.011              | 0.090             |                   |
|                      |              | (0.034)     | (0.055)            | (0.044)            |                     | (0.035)            | (0.054)             | (0.046)            |                   |                   |
| RP FIN → RISK PERC   |              | 0.195***    | 0.175***           | 0.211***           | -0.036*            | 0.195***           | 0.175***            | 0.211***           | -0.036*           |                   |
|                      |              | (0.009)     | (0.018)            | (0.012)            |                     | (0.009)            | (0.018)             | (0.012)            |                   |                   |
| RP INST → RISK PERC  |              | 0.206***    | 0.224***           | 0.221***           | 0.003              | 0.206***           | 0.224***            | 0.221***           | 0.003             |                   |
|                      |              | (0.011)     | (0.020)            | (0.014)            |                     | (0.011)            | (0.020)             | (0.014)            |                   |                   |
| RP PERS → RISK PERC  |              | 0.144***    |                    |                    |                     | 0.144***           |                     |                    |                   |                   |
|                      |              | (0.013)     |                    |                    |                     |                     | (0.013)             |                    |                   |                   |
| RP INPUT → RISK PERC |              | 0.203***    | 0.213***           | 0.221***           | -0.008             | 0.203***           | 0.213***            | 0.221***           | -0.008            |                   |
|                      |              | (0.009)     | (0.016)            | (0.012)            |                     | (0.009)            | (0.016)             | (0.012)            |                   |                   |
| RP MARKET → RISK PERC|              | 0.218***    | 0.247***           | 0.228***           | 0.019              | 0.218***           | 0.247***            | 0.228***           | 0.019             |                   |
|                      |              | (0.008)     | (0.013)            | (0.012)            |                     | (0.008)            | (0.013)             | (0.012)            |                   |                   |
| RP PROD → RISK PERC  |              | 0.160***    | 0.189***           | 0.150***           | 0.039              | 0.160***           | 0.189***            | 0.150***           | 0.039             |                   |
|                      |              | (0.010)     | (0.020)            | (0.016)            |                     | (0.010)            | (0.020)             | (0.016)            |                   |                   |
| RP SC → RISK PERC    |              | 0.232***    | 0.236***           | 0.258***           | -0.022             | 0.232***           | 0.236***            | 0.258***           | -0.022            |                   |
|                      |              | (0.008)     | (0.012)            | (0.011)            |                     | (0.008)            | (0.012)             | (0.011)            |                   |                   |
| RP SOC → RISK PERC   |              | 0.183***    | 0.188***           | 0.201***           | -0.013             | 0.183***           | 0.188***            | 0.201***           | -0.013            |                   |
|                      |              | (0.010)     | (0.015)            | (0.014)            |                     | (0.010)            | (0.015)             | (0.014)            |                   |                   |
Robustness

| Path                  | Coefficient   | Standard Error | Coefficient   | Standard Error |
|-----------------------|---------------|----------------|---------------|----------------|
| **RISK PERC → ROB**   | -0.098**      | (0.039)        | -0.002        | (0.074)        |
|                       | -0.139***     | (0.045)        | 0.138*        | (0.045)        |
| **RP FIN → ROB**      | -0.019**      | (0.008)        | 0.000         | (0.013)        |
|                       | -0.029***     | (0.008)        | 0.029*        | (0.013)        |
| **RP INST → ROB**     | -0.020**      | (0.008)        | 0.000         | (0.017)        |
|                       | -0.031***     | (0.008)        | 0.030         | (0.017)        |
| **RP PERS → ROB**     | -0.014**      | (0.006)        |               |                |
| **RP INPUT → ROB**    | -0.020**      | (0.008)        | 0.000         | (0.016)        |
|                       | -0.031***     | (0.008)        | 0.030*        | (0.016)        |
| **RP MARKET → ROB**   | -0.021**      | (0.008)        | 0.000         | (0.018)        |
|                       | -0.032***     | (0.008)        | 0.031*        | (0.018)        |
| **RP PROD → ROB**     | -0.016***     | (0.006)        | 0.000         | (0.014)        |
|                       | -0.021***     | (0.006)        | 0.021*        | (0.014)        |
| **RP SC → ROB**       | -0.023**      | (0.009)        | 0.000         | (0.017)        |
|                       | -0.036***     | (0.009)        | 0.036*        | (0.017)        |
| **RP SOC → ROB**      | -0.018**      | (0.007)        | 0.000         | (0.014)        |
|                       | -0.028***     | (0.007)        | 0.028*        | (0.014)        |
| **RISK PREF → ROB**   | 0.096**       | (0.007)        | 0.205***      | (0.014)        |
|                       | 0.026         | (0.007)        | 0.180**       | (0.014)        |
|                       | 0.088**       | (0.007)        | 0.205***      | (0.014)        |
|                       | 0.027         | (0.007)        | 0.178**       | (0.009)        |
| Path | Coefficients |
|------|--------------|
| RM → ROB | (0.042)       (0.073)       (0.052)       (0.041)       (0.071)       (0.051)       (0.032)       (0.055)       (0.039)       (0.037)       (0.063)       (0.046) |
| -0.018   -0.045   0.005   -0.049   0.027   0.063   0.017   0.046 |
| INNO → ROB | (0.040)       (0.069)       (0.048)       (0.040)       (0.069)       (0.048) |
| -0.044   -0.085   -0.036   -0.049   -0.044   -0.085   -0.036   -0.049 |
| NET FOR → ROB | (0.044)       (0.073)       (0.054)       (0.044)       (0.073)       (0.054) |
| 0.093**   -0.017   0.149***   -0.166*   0.093**   -0.017   0.149***   -0.166* |
| NET INF → ROB | (0.038)       (0.061)       (0.051)       (0.038)       (0.061)       (0.051) |
| -0.013   0.067   -0.049   0.116   -0.013   0.067   -0.049   0.116 |
| PBC → ROB | (0.041)       (0.073)       (0.049)       (0.040)       (0.072)       (0.048) |
| 0.351***   0.356***   0.350***   0.005   0.365***   0.356***   0.370***   -0.014 |

Adaptability

| Path | Coefficients |
|------|--------------|
| RISK PERC → ADAP | (0.033)       (0.057)       (0.041)       (0.033)       (0.057)       (0.041) |
| -0.028   0.017   -0.059   0.076   -0.028   0.017   -0.059   0.076 |
| RP FIN → ADAP | (0.006)       (0.010)       (0.009) |
| -0.006   0.003   -0.012   0.015 |
| RP INST → ADAP | (0.007)       (0.013)       (0.009) |
| -0.006   0.004   -0.013   0.017 |
| RP PERS → ADAP | -0.004 |
| Source             | Target  | Coefficient 1 | Coefficient 2 | Coefficient 3 | Coefficient 4 | p-value 1 | p-value 2 | p-value 3 | p-value 4 |
|--------------------|---------|---------------|---------------|---------------|---------------|-----------|-----------|-----------|-----------|
| RP INPUT → ADAP    |         | -0.006        | 0.004         | -0.013        | 0.017         | (0.005)   |           |           |           |
| RP MARKET → ADAP   |         | -0.006        | 0.004         | -0.013        | 0.018         | (0.007)   | (0.012)   | (0.009)   |           |
| RP PROD → ADAP     |         | -0.005        | 0.003         | -0.009        | 0.012         | (0.005)   | (0.011)   | (0.006)   |           |
| RP SC → ADAP       |         | -0.007        | 0.004         | -0.015        | 0.019         | (0.008)   | (0.014)   | (0.011)   |           |
| RP SOC → ADAP      |         | -0.005        | 0.003         | -0.012        | 0.015         | (0.006)   | (0.011)   | (0.008)   |           |
| RISK PREFERENCES    |         | 0.156***      | 0.141**       | 0.164***      | -0.022        | 0.153***  | 0.145**   | 0.164***  | -0.019    |
| RM → ADAP           |         | 0.057**       | 0.049         | 0.056         | -0.008        | 0.130***  | 0.150***  | 0.116***  | 0.034     |
| INNO → ADAP         |         | 0.106***      | 0.058         | 0.132***      | -0.074        | 0.106***  | 0.058     | 0.132***  | -0.074    |
| NET FOR → ADAP      |         | 0.073*        | 0.136**       | 0.041         | 0.095         | 0.073*    | 0.136**   | 0.041     | 0.095     |
| NET INF → ADAP      |         | 0.031         | 0.062         | 0.019         | 0.043         | 0.031     | 0.062     | 0.019     | 0.043     |
### PBC → ADAP

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
|        |        |        |        |        |        |        |
| 0.371*** | 0.386*** | 0.358*** | 0.027 | 0.375*** | 0.383*** | 0.367*** | 0.017 |

### Transformability

#### RISK PERC → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.047 | -0.054 | -0.035 | -0.018 | -0.047 | -0.054 | -0.035 | -0.018 |

#### RP FIN → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.009 | -0.009 | -0.007 | -0.002 |        |        |        |        |

#### RP INST → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.010 | -0.012 | -0.008 | -0.004 |        |        |        |        |

#### RP PERS → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.007 |        |        |        |        |        |        |

#### RP INPUT → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.010 | -0.011 | -0.008 | -0.004 |        |        |        |        |

#### RP MARKET → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.010 | -0.013 | -0.008 | -0.005 |        |        |        |        |

#### RP PROD → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.008 | -0.010 | -0.005 | -0.005 |        |        |        |        |

#### RP SC → TRANS

|        |        |        |        |        |        |        |
|--------|--------|--------|--------|--------|--------|--------|
| -0.011 | -0.013 | -0.009 | -0.004 |        |        |        |        |
| Source | Target | Regressors | Coefficients | Standard Errors |
|--------|--------|------------|--------------|----------------|
| RP SOC → TRANS | | | -0.009 (0.007) | -0.010 (0.011) | -0.007 (0.009) | -0.003 (0.007) |
| RISK PREF → TRANS | | 0.212*** (0.044) | 0.202*** (0.068) | 0.212*** (0.055) | -0.010 (0.044) | 0.209*** (0.067) | 0.191*** (0.055) | 0.212*** (0.009) | -0.022 (0.044) |
| RM → TRANS | -0.027 (0.030) | 0.000 (0.051) | -0.045 (0.038) | 0.046 (0.038) | 0.057 (0.038) | 0.112* (0.061) | 0.031 (0.048) | 0.081 (0.048) |
| INNO → TRANS | 0.012 (0.047) | -0.051 (0.072) | 0.045 (0.058) | -0.096 (0.047) | 0.012 (0.072) | -0.051 (0.058) | 0.045 (0.048) | -0.096 (0.058) |
| NET FOR → TRANS | 0.062 (0.041) | 0.055 (0.067) | 0.071 (0.053) | -0.016 (0.041) | 0.062 (0.067) | 0.055 (0.053) | 0.071 (0.053) | -0.016 (0.053) |
| NET INF → TRANS | -0.020 (0.037) | 0.050 (0.057) | -0.065 (0.050) | 0.115 (0.037) | -0.020 (0.050) | 0.050 (0.057) | -0.065 (0.057) | 0.115 (0.050) |
| PBC → TRANS | 0.385*** (0.038) | 0.422*** (0.065) | 0.367*** (0.048) | 0.055 (0.038) | 0.392*** (0.063) | 0.429*** (0.049) | 0.372*** (0.049) | 0.057 (0.049) |

Resilience

| Source | Target | Regressors | Coefficients | Standard Errors |
|--------|--------|------------|--------------|----------------|
| ADAP → RES | | | 0.230*** (0.046) | 0.284*** (0.070) | 0.200*** (0.057) | 0.085 (0.046) | 0.230*** (0.070) | 0.284*** (0.057) | 0.200*** (0.057) | 0.085 (0.057) |
| ROB → RES | | | 0.267*** (0.037) | 0.245*** (0.057) | 0.289*** -0.043 (0.046) | 0.267*** (0.057) | 0.245*** -0.043 (0.046) | 0.289*** (0.057) | 0.085 (0.057) | 0.085 (0.057) |
| Relationship       | Coefficient 1 | Coefficient 2 | Coefficient 3 | Coefficient 4 | Coefficient 5 |
|-------------------|--------------|--------------|--------------|--------------|--------------|
| TRANS → RES       | 0.114**      | 0.113        | 0.108*       | 0.005        | 0.114**      |
|                   | (0.047)      | (0.071)      | (0.060)      |              | (0.047)      |
| RISK PERC → RES   | -0.038**     | -0.001       | -0.056**     | 0.054        |              |
|                   | (0.018)      | (0.035)      | (0.022)      |              |              |
| RP FIN → RES      | -0.007**     | 0.000        | -0.012**     | 0.012        |              |
|                   | (0.004)      | (0.006)      | (0.005)      |              |              |
| RP INST → RES     | -0.008**     | 0.000        | -0.012**     | 0.012        |              |
|                   | (0.004)      | (0.008)      | (0.005)      |              |              |
| RP PERS → RES     | -0.005**     |              |              |              |              |
|                   | (0.003)      |              |              |              |              |
| RP INPUT → RES    | -0.008**     | 0.000        | -0.012***    | 0.012        |              |
|                   | (0.004)      | (0.007)      | (0.005)      |              |              |
| RP MARKET → RES   | -0.008**     | 0.000        | -0.013**     | 0.012        |              |
|                   | (0.004)      | (0.009)      | (0.005)      |              |              |
| RP PROD → RES     | -0.006**     | 0.000        | -0.008**     | 0.008        |              |
|                   | (0.003)      | (0.007)      | (0.003)      |              |              |
| RP SC → RES       | -0.009**     | 0.000        | -0.014**     | 0.014        |              |
|                   | (0.004)      | (0.008)      | (0.006)      |              |              |
| RP SOC → RES      | -0.007**     | 0.000        | -0.011**     | 0.011        |              |

20
| Source       | Destination | Coefficient 1 | Coefficient 2 | Coefficient 3 | Coefficient 4 |
|--------------|-------------|---------------|---------------|---------------|---------------|
| RISK PREF    | RES         | 0.083***      | 0.113***      | 0.063**       | 0.050         |
|              |             | (0.021)       | (0.035)       | (0.027)       |               |
| RM           | RES         | 0.043**       | 0.071**       | 0.031         | 0.039         |
|              |             | (0.019)       | (0.034)       | (0.024)       |               |
| INNO         | RES         | 0.014         | -0.010        | 0.021         | -0.031        |
|              |             | (0.019)       | (0.035)       | (0.022)       |               |
| NET FOR      | RES         | 0.049**       | 0.041         | 0.059**       | -0.018        |
|              |             | (0.022)       | (0.037)       | (0.027)       |               |
| NET INF      | RES         | 0.001         | 0.040         | -0.017        | 0.057         |
|              |             | (0.018)       | (0.029)       | (0.024)       |               |
| PBC          | RES         | 0.229***      | 0.245***      | 0.220***      | 0.025         |
|              |             | (0.024)       | (0.047)       | (0.026)       |               |
Table A1.11. Summary statistics all farmers, *Low*, and *High*.

|                       | All (N = 916) | Low (N = 329) | High (N = 587) |
|-----------------------|--------------|--------------|---------------|
| **Risk behavior**     |              |              |               |
| *RM*                  | 3.98 1.35    | 3.94 1.36    | 4.01 1.35     |
| **RISK PERC**         |              |              |               |
| *RISK PERC_1*        |              |              |               |
| riskperc_1            | 4.44 1.53    | 4.41 1.47    | 4.46 1.56     |
| riskperc_2            | 4.16 1.47    | 4.14 1.43    | 4.17 1.49     |
| **RISK PERC_2**       |              |              |               |
| riskperc_3            | 4.91 1.62    | 4.69 1.61    | 5.04*** 1.62  |
| riskperc_4            | 4.78 1.45    | 4.77 1.44    | 4.78 1.46     |
| **RISK PERC_3**       |              |              |               |
| riskperc_5            | 4.93 1.70    | 4.70 1.73    | 5.06*** 1.67  |
| riskperc_6            | 4.02 1.54    | 4.03 1.46    | 4.02 1.59     |
| **RISK PERC_4**       |              |              |               |
| riskperc_7            | 4.17 1.74    | 4.02 1.73    | 4.26** 1.75   |
| riskperc_8            | 3.42 1.75    | 3.49 1.63    | 3.39 1.81     |
| **RISK PERC_5**       |              |              |               |
| riskperc_9            | 4.50 1.61    | 4.52 1.61    | 4.49 1.61     |
| riskperc_10           | 4.38 1.56    | 4.33 1.53    | 4.41 1.57     |
| **RISK PERC_6**       |              |              |               |
| riskperc_11           | 3.71 1.95    | 3.77 1.99    | 3.67 1.92     |
| riskperc_12           | 3.20 1.67    | 3.17 1.62    | 3.22 1.70     |
| riskperc_13           | 3.68 1.99    | 3.62 1.97    | 3.72 2.00     |
| **RISK PERC_7**       |              |              |               |
| riskperc_14           | 5.51 1.50    | 5.27 1.57    | 5.65*** 1.45  |
| riskperc_15           | 4.36 1.92    | 4.21 1.91    | 4.44* 1.93    |
| **RISK PERC_8**       |              |              |               |
| riskperc_16           | 4.87 1.62    | 4.76 1.59    | 4.94 1.64     |
| riskperc_17           | 4.84 1.69    | 4.71 1.66    | 4.92* 1.71    |
| **RISK PREF**         |              |              |               |
| riskpref_1            | 4.08 1.49    | 4.18 1.43    | 4.03 1.53     |
| riskpref_2            | 4.39 1.50    | 4.64 1.42    | 4.26*** 1.52  |
| riskpref_3            | 4.15 1.40    | 4.27 1.36    | 4.08** 1.42   |
| riskpref_4            | 4.35 1.35    | 4.42 1.34    | 4.32 1.36     |

**Resilience**

| **ROB**               |              |              |               |
| rob_1                 | 4.21 1.43    | 4.36 1.32    | 4.13** 1.48   |
| rob_2                 | 3.90 1.54    | 3.90 1.48    | 3.90 1.57     |
| rob_3                 | 4.44 1.47    | 4.55 1.42    | 4.38* 1.50    |
| rob_4                 | 4.02 1.53    | 4.18 1.43    | 3.94** 1.58   |

| **ADAP**              |              |              |               |
| adap_1                | 3.97 1.71    | 4.05 1.78    | 3.93 1.66     |
| adap_2                | 4.58 1.42    | 4.64 1.40    | 4.54 1.42     |
| adap_3                | 4.65 1.37    | 4.71 1.40    | 4.61 1.36     |
|          | Mean 1 | Mean 2 | Mean 3 | Mean 4 | Mean 5 |
|----------|--------|--------|--------|--------|--------|
| adap_4   | 4.57   | 1.59   | 4.76   | 1.54   | 4.45***|
| TRANS    | 3.84   | 1.58   | 4.00   | 1.57   | 3.75**  |
| trans_1  | 4.08   | 1.56   | 4.23   | 1.50   | 4.00**  |
| trans_2  | 3.98   | 1.46   | 4.23   | 1.48   | 3.84*** |
| trans_3  | 3.72   | 1.57   | 3.98   | 1.60   | 3.58*** |
| RES      | 4.87   | 1.47   | 4.98   | 1.43   | 4.81*   |
| res_1    | 4.38   | 1.59   | 4.43   | 1.62   | 4.35    |

**Control variables**

| INNO     |        |        |        |        |
|----------|--------|--------|--------|--------|
| inno_1   | 4.15   | 1.58   | 4.37   | 1.59   | 4.02*** |
| inno_2   | 4.12   | 1.58   | 4.25   | 1.56   | 4.04*** |
| NET INF  |        |        |        |        |
| net_1    | 5.62   | 1.31   | 5.60   | 1.33   | 5.63    |
| net_2    | 4.98   | 1.47   | 4.93   | 1.48   | 5.01    |
| net_3    | 4.28   | 1.52   | 4.39   | 1.57   | 4.21*   |
| NET FOR  |        |        |        |        |
| net_4    | 5.09   | 1.35   | 5.14   | 1.26   | 5.07    |
| net_5    | 4.56   | 1.49   | 4.69   | 1.40   | 4.48**  |
| net_6    | 4.66   | 1.50   | 4.82   | 1.42   | 4.57**  |
| PBC      |        |        |        |        |
| pbc_1    | 4.64   | 1.30   | 4.79   | 1.28   | 4.56**  |
| pbc_2    | 4.78   | 1.43   | 4.87   | 1.39   | 4.73    |
| pbc_3    | 3.96   | 1.45   | 4.07   | 1.49   | 3.90*   |
| pbc_4    | 4.43   | 1.46   | 4.51   | 1.50   | 4.38    |

Notes: All items are measured on a 7-point Likert scale, except the diversity of risk management strategies (RM). This item is the count of different types of risk management strategies, ranging from 0 to 7. Significant differences between Low and High were tested using a t-test. * p≤0.10; ** p≤0.05; *** p≤0.01.