CULTURE, KNOWLEDGE AND RISKS: INSIGHTS FROM RURAL VIETNAM

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ABSTRACT

An understanding of risk attitudes is vital to assess economic behaviors, decision-making and economic outcomes. Therefore, studies on risk attitudes provide insights into social protection policies aiming at the disadvantaged groups particularly in low-income countries. However, debate continues on an effective measure of risk attitudes and on the relationship between risk attitudes and economic wellbeing. Particularly, challenges arise from widely diverse populations with respect to cultural and socioeconomic backgrounds. A large and growing body of literature has investigated the relationship between risk attitudes and economic welfare. However, the results of those studies were far from a consensus ranging from an insignificant to a significant negative or positive correlation. Additionally, knowledge including both formal education and subjective knowledge plays an important role in economic decision-making and economic outcomes. Moreover, risk-taking enhances the learning process and technology adoption that subsequently improve livelihoods. Therefore, it is critical to evaluate the interrelation between knowledge and risk attitudes in economic behaviors, decision-making and economic outcomes. Furthermore, many studies have highlighted the role of cultural factors in human behaviors and attitudes including that towards risks. Therefore, understanding of the variation of risk attitudes across different cultural groups could shed light on the linkage between culture and economic development, poverty and inequality. A multiethnic population of rural Vietnam serves as an interesting sample to investigate the involvement of cultural factors in the aforementioned issues. More specifically, Vietnam has 53 ethnic minority groups that mostly concentrate in rural and remote areas are more likely to experience chronic poverty. The economic gap between ethnic minorities and the ethnic majority (Kinh) is increasing despite the remarkable success in economic growth of that country in the recent decades. Empirical evidence attributed the existing ethnic gap in Vietnam to the difference in endowments or to the returns to endowments across groups. However, little is known about whether risk attitudes that differ across ethnic groups could contribute to a deeper understanding of why the efforts towards poverty alleviation are likely to be less effective among ethnic minorities.

The primary objective of this thesis is to measure attitudes towards risks and examine the relationship between risk attitudes and decision-making and economic welfare among a multiethnic population of rural Vietnam. It is also to understand farmers' knowledge and relations among risk attitudes, knowledge and economic outcomes. The first specific objective is to evaluate the survey-based measure of risk attitudes. This survey question is

expected to capture the intrinsic or the most general individual attitudes towards risks. By applying it on heterogeneous subjects, this research aims to explore the important predicting factors of risk attitudes among cultural and socioeconomic variables. The second objective seeks for evidence of a complex relationship between risk attitudes and economic welfare among multiethnic communities. The third objective is to examine the relations between farmers' risk attitudes, knowledge, management ability and agricultural productivity.

Data used to explore the objectives are sourced from the long-term socioeconomic panel household survey conducted in Vietnam and Thailand (TVSEP) since 2007 in three provinces of each country. In this thesis, the data from two provinces in the Central Vietnam, namely Dak Lak and Thua Thien Hue (Hue) are used. Additionally, the thesis is based on data collected by a special survey particularly conducted with the households in Hue province in 2014 and 2015.

The first essay documents the validity of a survey question to measure risk attitudes that is assessed by its significant correlations with the individual and household characteristics and by its power to predict outcomes of a risk experiment. Multivariate analysis method is applied using Interval regression, Ordered Probit and OLS regression models under various specifications. The robust results confirm that the individual risk attitudes measured by a survey question can be significantly explained by the individual characteristics such as height, education and ethnicity. The results remain consistent when controlling for further socioeconomic backgrounds. This study documents significant difference in risk attitudes between the ethnic majority and the ethnic minority. Furthermore, the survey-based measure consistently predicts risky behaviors and its predictive power remains consistent across models and specifications. The results confirm that the survey-based item is effective to measure risk attitudes of a multiethnic community

The second essay introduces an exploration into the relationship between economic welfare and risk attitudes in the presence of socioeconomic and cultural diversity of different ethnic groups. The results indicate differences in both risk attitudes and economic welfare between the ethnic majority and the ethnic minorities. Furthermore, the willingness to take risks significantly diverges among the ethnic minorities, although they are economically homogenous. Empirically, in the first step, a quadratic form of risk attitudes is added to test whether there is a non-linear relationship between risk attitudes and economic welfare when analyzing a mixed sample of the ethnic minority groups. The results from a fixed effects model and a correlated random effects model, namely Hausman -Taylor confirms a U-shaped

relationship between risk-taking and economic welfare with a switch from negative to positive when the willingness to take risk reaches a certain threshold on the eleven-point Likert scale. In the second step, a positive and mutual relationship between risk-taking and economic welfare among the ethnic majority is tested by employing a simultaneous estimation using the Three Stage Least Square method. The results show that an increase in the willingness to take risks by one point associates with an increase in economic welfare by about 7%.

The third essay presents an examination of the relationships among farmers' risk attitudes, knowledge, decision-making skills and agricultural performance. Risk attitudes are measured by alternative methods and farmers' knowledge is scored by using a set of two-choice questions and farmers' subjective knowledge is measured by using five point Likert scale, separately for crop and livestock production. Farmers' decision-making skill is tested by using decision games separately for crop and livestock. Indicators of agricultural performance are calculated from the average outcomes of the main agricultural activities such as crop and livestock production using data from a long panel survey. The results show that farmers' performance has significant correlation with their subjective knowledge, albeit unlikely with technical knowledge. Farmers received limited support from the extension institutions and tend to be risk-averse. Compared with crop production, farmers have better knowledge livestock and they performed better in the decision game in respect to livestock production.

This thesis contributes to scientific literature that can be useful for policy-making in different ways. Firstly, the findings strengthen the strand of studies that uses a survey question to measure individual risk attitudes by applying this measure on culturally diverse and low-educated agents. Secondly, the thesis emphasizes the role of cultural factors characterized by ethnicity in the variation of risk attitudes and economic welfare. It sheds light on the controversial mixed results of the relationship between risk attitudes and economic welfare in literature. The results document the driving force of cultural factors in risk attitudes and the association among risk attitudes, decision-making and economic welfare. Thirdly, the results indicate a large variation in farmers' knowledge and a strong tendency of risk aversion among the target sample of farmers. Agricultural productivity is more likely related to subjective knowledge rather than to technical knowledge and ability. A need to improve farmers' technical knowledge and management skills is suggested to enhance agricultural productivity. Additionally, the thesis suggests social protection policies to consider risk-taking, particularly when targeting different small ethnic groups and less knowledgeable farmers. Fourthly, the

focal methodological contribution is that the thesis introduces new approaches to examine the complex relationship between risk attitudes and economic welfare, particularly in the context of multiethnic populations. Finally, the thesis introduces the involvement of cultural factors in altering risk attitudes and its relationship with economic welfare. Thus, it provides insights into complex effects of cultural factors and the divergence of risky behaviors and knowledge on economic development and inequality.

Keywords: risk attitudes, household economic welfare, ethnicity

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LIST OF ABBREVIATIONS

3SLS	Three Stage Least Square
ANOVA	Analysis of Variance
Chi2	Chi square test
e.g.	exempli gratia
GSO	General Statistics Office
i.e.	id est
INV	Hypothetical risky investment
N	Number of observations
N.a.	Not available
OLS	Ordinary Least Squares
PEGNet	Poverty Reduction, Equity and Growth Network
PPP	Purchasing Power Parity
SOEP	Socio-Economic Panel
SR	Switching Row
TVSEP	Thailand Vietnam Socio Economic Panel (www.tvsep.de)
USD	US Dollar
VHLSS	Vietnam Household Living Standards Survey
VND	Vietnam Dong
WB	World Bank
WTR	Willingness to Take Risks

CHAPTER 1

INTRODUCTION

1.1 Motivation

Understanding of risk attitude and its relationship with economic welfare is necessary for effective social protection and economic development policies. However, current studies have not reached an agreement on which measure is effective to measure risk attitudes and how risk attitudes and economic welfare related is, in particular among a heterogeneous population. In literature, the two prominent methods have been used to measure risk attitudes including the survey question and the risk experiment. On the one hand, the incentivized field experiments are reliable as they allow measuring risk aversion with respect to the shapes of the utility function (e.g., Charness, Gneezy & Imas, 2013). On the other hand, field experiments are expensive and time-consuming. Therefore, they can hardly be carried out on a large number of respondents. Some of those studies are subject to a skeptical discussion regarding the consistency and reliability in time or space dimensions of the measurement (e.g., Chuang & Schechter, 2015; Cook, 2015; Filippin & Crosetto, 2016). An increasing number of studies have found that the survey-based measure allows for acquiring information about the individual risk attitudes from larger populations in the context of household surveys. The outcomes of this survey question are more stable when being applied over time in comparison to an experimental measure (Lönnqvist, Verkasalo, Walkowitz & Wichardt, 2015). Moreover, this survey question is found to predict the real-life risky behaviors and the outcomes of a risk experiment across populations (e.g., Dohmen et al., 2011; Hardeweg, Menkhoff & Waibel, 2013). Especially, the survey-based measure is suggested to be more suitable to apply in developing countries where people often have low education (Chuang & Schechter, 2015). In addition, this survey question is recommended for comparing risk attitudes across countries or cultures (Vieider et al., 2015) and to capture the underlying component of risk attitudes that are robust across different contexts and domains (Dohmen et al., 2011; Einav et al., 2012).

Risk attitude affects economic decision-making and consequently results in variations of economic outcomes. At the same time, the change of risk attitudes over time is found to be a crucial element in the economic growth (Klasing, 2014; Doepke & Zilibotti, 2014). In other words, risk preferences can be a cause and a consequence of the economic growth. In the presence of poverty, risk aversion seems to be a psychological negative consequence of living

in economic constraints (Haushofer & Fehr, 2014). In its turn, risk aversion could trap the poor into persistent poverty when they are not willing to take risks in the high-risk and high-return opportunities due to their limited capacity to manage risks (Mosley & Verschoor, 2005). However, the empirical evidence to date has not reached a consensus, since the previous studies that worked on the correlation relationship between risk preferences and economic welfare reported mixed results. In particular, limit to the studies conducted in the context of developing countries, the results on the correlation between risk aversion and economic welfare are ranging from insignificant to significantly negative and positive (e.g., Binswanger, 1980; Liebenehm & Waibel, 2014; Tanaka, Camerer, & Nguyen, 2010; Vieider, Truong, Martinsson & Nam, 2013; Yesuf & Bluffstone, 2009). Bouchouicha and Vieider (2017) indicated that the relationship between income and risk tolerance switches its direction from positive within countries to negative across countries. Hence, further empirical evidence of whether culture alters the relationship between risk attitudes and economic welfare is required to solve this puzzle. Furthermore, a mutual association was also suspected by some researchers such as Tanaka et al. (2010) and Cardenas and Carpenter (2013) who did not find a significant correlation between risk attitudes and economic welfare. Hence, evidence of a mutual interdependency between risk attitudes and economic welfare and what factors drive this bidirectional relationship could contribute to the understanding of the abovementioned mixed results.

The target sample of farmers in rural areas of Central Vietnam motivates us to examine the involvement of risk attitudes in livelihoods and economic welfare among a diverse population as well as across different ethnic groups. As an emerging country, Vietnam has reduced poverty successfully; however, it is continuingly facing inequality, for instance, across social groups. To illustrate, many studies reported a significant gap in living standards between the ethnic minorities and the ethnic majority (e.g., Baulch, 2011; Kozel, V. (Ed.), 2014; World Bank, 2009). Challengingly, many efforts of the government to bridge this gap have not been effective (e.g., Fritzen, 2002; Kang & Imai, 2012). The reasons are summarized in the following; first, the programs targeted at the same time both poverty-alleviation and inequality-reduction across different ethnic groups, while ethnicity can be endogenous in the economic development pathways. Second, the ethnic diversity itself could cause poverty and inequality directly. Indeed, cultural factors have been a focus of the studies that seek for evidence of the role of cultural factors in shaping human attitudes and behaviors, including that towards risks (Vieider et al., 2014b). Consequently, cultural factors have been found to be the important factors of economic development (Throsby, 2001). Missing of those factors

might cause confusion between ethnic issues and poverty problems (DeJaeghere, Wu & Vu, 2015) consequently lead to inappropriate policies to pursue development goals.

This thesis uses a survey-based measure of risk attitudes (i.e. the willingness to take risks), in particular, to apply for a culturally diverse population in rural areas of Central Vietnam. Successively, it targets to contribute towards a deeper understanding of the role of the risk attitudes in decision-making and economic wellbeing. First, the thesis reinforces the use of the survey-based instrument to elicit risk preferences and to assess the effect of risk attitudes on decision-making and economic outcomes across social groups. Second, the role of risk attitudes and knowledge is examined to explain the decision-making and agricultural performance among a sample of rural Vietnamese farming households. Third, the relationship between risk attitudes and economic welfare is investigated through different approaches in the presence of the socioeconomic and cultural diversity. Additionally, to understand farmers' productivity, we question whether there exist the relationships among farmers' knowledge, the willingness to take risks, management skill and agricultural productivity. In sum, the studies comprising this thesis aim to enrich the literature devoted to elicit the individual risk preferences and to examine the importance of risk preferences in economic outcomes. In addition, the thesis targets the role of cultural factors in shaping risk attitudes and economic welfare. Consequently, it seeks to shed light on the poverty and inequality problems, particularly in culturally diverse communities.

1.2 Background of the study sample

The data used in this thesis are a part of a long-term socio-economic survey (TVSEP, www.tvsep.de) that has been implemented in six provinces in Thailand and Vietnam since 2007. The initial sample included 4,400 households in 440 villages (Klasen & Waibel, 2013). The sample was selected based on a stratified three stages sampling procedure whereby the provinces (in this thesis Dak Lak province and Hue province) were purposively chosen. Due to the large heterogeneity in population density, the province was subdivided into agro-ecological zones, namely the lowland and the mountain zones for Dak Lak and three zones, namely the coastal, the lowland and the highland areas for Hue. Within each zone, communes were selected according to the weight of rural population shares. In the second stage, villages were chosen by the probability proportional to the population size. Finally, ten households were randomly selected in each village. In 2014 and 2015, special surveys were conducted in Hue province with the respondents of the panel. The surveys focused on risk, financial literacy agricultural knowledge and decision-making skills in agriculture and related business

and only included some components of the income generating activities, i.e. input and output data for crop and livestock. We employed different methods to measure risk attitudes and farmers' knowledge. To evaluate farmers' management ability, we applied various games, tests and self-assessing measures (see Appendix B for some sections of the survey questionnaire).

The research sample in this thesis is characterized by the ethnic diversity, agricultural dependency, high poverty incidence and ethnic inequality. Those characteristics are briefly described in the following.

1.2.1 Ethnic diversity

As a multiethnic country, Vietnam has 53 ethnic minority groups making up 15 percent of the population. The ethnic majority, namely Kinh, contributes to the rest of the population. Even though the ethnic minorities have different languages and cultures, the official language is Vietnamese, the language of the ethnic majority. Along the pathways to adopt the modern civilization, the languages and cultures of the small ethnic groups have been deteriorating (Salemink, 2001). Nevertheless, maintaining the cultural heritages of the ethnic minority groups is one of the development goals of Vietnamese government. This goal generates a challenge to achieve equal development across ethnic groups and at the same time to retain the cultural values of each group. In addition, the ethnic minorities are concentrated more likely in the remote, rural and mountainous areas of the country (Figure 1.1, right map). Therefore, the national poverty scatter mostly overlaps the distribution of the ethnic minorities.
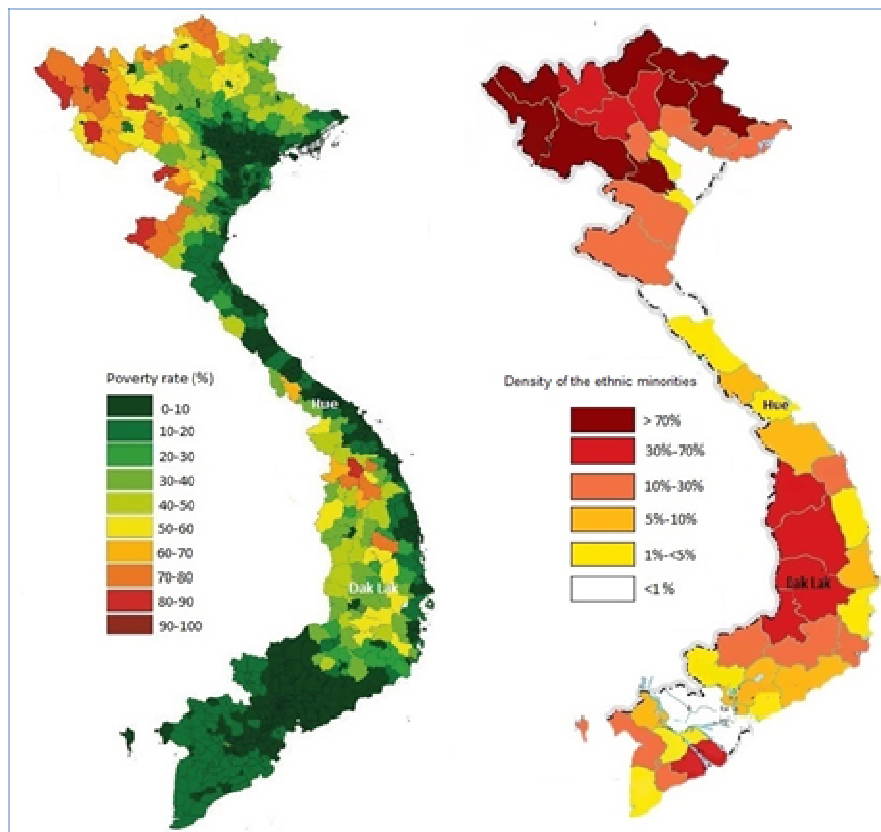
Figure 1.1: Poverty and ethnic diversity in Vietnam

Sources: World Bank Vietnam 2016 (left map) and World Health Organization 2003 (right map), modified

The rural areas of these two provinces that comprise the research sample of this thesis represent the ethnic diversity of the country. In both provinces, the ethnic diversity is significantly high in comparison with the national average. Although, the density of the ethnic minorities is low on average in Hue province, the ethnic minorities are mostly located in rural mountainous areas. Hence, the contribution of those ethnic minorities in the study sample is relatively high. In the final study sample, we find above 20 percent of the sample in Hue are ethnic minorities while it is above 30 percent in Dak Lak province.

1.2.2 The role of agriculture

As an agrarian economy, agriculture is a crucial economic sector in Vietnam as it employs a large proportion of the national labor force. Along the pathways of the economic reform, this proportion has been reducing. Indeed, the structural reformation shifted the labor force from agricultural to services and manufacturing sectors. However, agriculture remains one of the most important sectors of the economy by having almost half of the country's workforce engaging in small-scale agriculture (World Bank Group, 2016). In addition, agricultural

development is suggested as an instrument to reduce the urban-rural gap as well as the ethnic inequality (Benjamin, Brandt & McCaig, 2017).

Rural areas of Vietnam are undeveloped in many aspects and remain dependent on agriculture. Furthermore, agriculture is a risky business that involves significant uncertainty and risk. Particularly, Vietnam has high frequency of natural disasters resulting in agricultural shocks. Without a strong safety net, rural areas are also facing risks in changing demographic characteristics such as the decreasing labor-force in rural areas and in agriculture due to rural-urban migration to avoid risks of damages caused by shocks (Smith & Scarpaci, 2000). Therefore, increasing agricultural performance is necessary to improve livelihood in the rural areas and to contribute to bridging the rural-urban gap.

While agricultural efficiency in the mountainous areas is low, the poverty reduction programs from the Vietnamese government have been shown as ineffective (Kyeyune & Turner, 2016). The inefficiency of these programs mainly attributes to neglecting the agro-ecological and socio-cultural complexities of the mountainous areas and to the mismatched purposes among the policies. In addition, although the ethnic minorities have their own languages and their knowledge in Vietnamese language is limited, the interventions did not take into account these language barriers (e.g., Kyeyune & Turner, 2016; Turner, 2011). Moreover, the agricultural performance depends heavily on technologies; at the same time, knowledge and risk-taking are important elements in farmers' decision-making to adopt new technologies (e.g., Liu & Huang, 2013). Therefore, language barriers, consequently, education can be an obstacle for the ethnic minorities to understand and to adopt new technologies.

1.2.3 Socioeconomic gaps between the ethnic majority and the ethnic minorities

Vietnam has achieved impressive success in poverty reduction and urbanization. However, on the pathways to the economic growth, the structural transformation in Vietnam has been creating its own problems such as regional inequality and "pro-rich gains" (Sarma, Paul & Wan, 2017). Consequently, Vietnam is continuously confronting inequality problems such as urban-rural gap and ethnic disparities. To illustrate, some studies indicated that the rural and the ethnic minority communities are more likely living in poverty (e.g., Cuong, Truong & Van Der Weide, 2010; Lanjouw, Marra, & Nguyen, 2017). Therefore, there is an association between higher poverty and larger inequality, as seen in the map (Figure 1.1). The two maps of Figure 1.1 show an overlap between the high poverty intensity and the ethnic density in different regions, in particular, the poor and the ethnic minorities are more likely concentrated in the mountainous areas.

The ethnic minorities are left behind in many aspects; they are found even poorer in comparison to the majority group within areas where the density of the ethnic minorities is high (Cuong, Tung & Westbrook, 2015). The Vietnamese government has taken considerable effort to support the ethnic minorities, in particular, the groups who are located in the mountainous areas. Indeed, the ethnic minorities moderately benefited from the supporting project targeting poverty in the multiethnic areas (Cuong et al., 2015). However, the socioeconomic gap and the persistent food security challenges remain; there is even unequal improvement across ethnic minority groups. The ethnic minority groups who share similar socioeconomic and cultural backgrounds with the ethnic dominant group achieved better economic improvement, while other groups who remained strongly attached to their own values had less progress (Baulch et al., 2007). Some programs that aimed to provide agricultural extension and technology seemed not to reach their objectives (Bonnin & Turner, 2012). Probably, those interventions did not take into account the cultural and social differences among ethnic groups or based on the characteristics of the dominant group. In addition, the small ethnic minorities have obtained lower education and cognitive skills (Arouri, Ben-Youssef & Nguyen, 2016). Therefore, education has been attributed as one of the main causes of the wage inequality (Baulch et al., 2012). Because the limitation in ability to comprehend the information can decrease the livelihood to adopt interventions (Hiebert, 1974), these small groups have been apparently confronting the difficulties to adopt the standards that are based on the background of the dominant ethnic group (Tran & Walter, 2010).

There are gaps in many different aspects between the ethnic majority and the ethnic minorities. Among those aspects, a wide range of heterogeneities characterized by cultural and socioeconomic backgrounds could influence the variation in the general risk attitudes. In addition, the disadvantaged ethnic minorities have their own traditions that are thought to be more likely to deviate from the assumption of "homo economicus" (Montalvo & Reynal-Querol, 2005; Nguyen, 2012). Consequently, how to measure the general risk attitudes across ethnic groups controlling for all its factors among a highly culturally or socioeconomically diverse population is a challenge.

1.3 Conceptual framework

The current thesis works on the relation of different strands of literature. It is based on the role of risk attitudes in decision-making and subsequently, in economic outcomes. In addition, the thesis takes into account the strand of literature that submits to the influence of ethnic or

cultural diversity on risk-taking and consequently on economic development. The conceptual framework of this thesis is summarized in Figure 1.2 below. The figure explains the extent to which the ethnicity has an influence on economic outcomes.

Ethnicity has both direct and indirect effects on the economic outcomes. First, the direct channel explains the effect of the cultural factors such as languages, beliefs, social networks and social norms on economic cooperation across groups. They might cause the language barriers in the accessibility to public goods and financial systems that result in economic outcomes of the smaller ethnic groups. Second, the indirect channel explains how ethnicity shapes risk attitude; thereby its impact on economic outcomes. The details of the main elements of the aforementioned channels are summarized in the following.

1.3.1 Risk attitudes, economic decision-making and economic development

Risk-taking enhances economic development; at the national level, significant differences in risk attitudes are found within and across countries (Guiso & Paiella, 2008; Harrison, Lau, & Rutström, 2007). Similarly, Bouchouicha and Vieider (2017) suggested that the relationship between risk attitudes and economic welfare is driven by the stages of economic growth. At the household level, risk-taking is found to be passed from parents to their children (Dohmen et al., 2012), while risk-taking drives entrepreneurship that leads to endogenous economic growth (Klasing, 2014). At the individual level, risk-taking influences occupational choices (Bonin, Dohmen, Falk, Huffman & Sunde, 2007). Furthermore, more risk-taking increases the probability that a person chooses to be self-employed (Caliendo, Fossen & Kritikos, 2009; Cramer, Hartog, Jonker & Van Praag, 2002). Similarly, risk-taking encourages adoption to technologies (Liu & Huang, 2013).

Risk aversion could be due to an economically disadvantaged background. Indeed, risk aversion is found to be associated with poverty and can be an obstacle to poverty reduction (e.g., Klasen et al., 2015; Günther & Maier, 2014). Similarly, the poor people tend to involve in risk-averse income smoothing strategies (Rosenzweig & Binswanger, 1992), likewise, they are prone to be risk-averse in using labor (Jayachandran, 2006) and more reluctant to adopt new agricultural technologies (Liu, 2013). Therefore, risk aversion has become a key element to understanding persistent poverty among the poor (Mosley & Verschoor, 2005). One could ask whether risk aversion explains the economic inequality across the agents whose risk attitudes are correlated with their economic outcomes.

1.3.2 Risk attitude and learning about agricultural technologies

Knowledge including both the technical and the experiential enhances the ability to comprehend the information that supports decision-making and consequently the performance of farmers. Education has indirect effect on decision-making by encouraging risk-taking behaviors since it reduces the uncertainty in decision environment. Risk plays an important role in agricultural decision-making and technology adoption (Sunding & Zilberman, 2001), consequently influences agricultural development. Knowledge encourages technology adoption and supports agricultural decision-making (e.g., Foster & Rosenzweig, 1995). Indeed, farmers' knowledge in resources and environment has significant effect on management decision (Waibel & Zilberman, 2007). Therefore, the interrelation between risk attitudes and knowledge interact could influence management decision-making of farmers. In particular, management decision requires farmers to have ability and capacity to justify the alternatives of technology that they have (Schultz, 1975). Knowledge or learning process as well as elements of education such as cognitive skill and the confidence of the decision makers are crucial in making good decisions. For instance, the importance of farmer empowerment is emphasized in agricultural development projects (e.g., World Bank, 2012).

1.3.3 Cultural factors, risk attitudes and inequality

Cultural factors such as ethnicity, religion and nationality play a role in shaping risk attitudes since many studies found that risk attitudes vary across religions, races and nationalities (e.g., Coleman, 2003; Nielsen et al., 2017; Hilary & Hui, 2009; Weber, 2013). Indeed, since cultural and social factors influence human attitudes and behaviors (Hoff & Stiglitz, 2016), subsequently, shape their economic outcomes (Guiso, Sapienza & Zingales, 2006). Furthermore, ethnic identity mainly defines languages, social networks, and cultural heritage that result in social norms and social identity of the members of an ethnic group. These elements characterize the diversity in social and cultural aspects of a society. In addition, these factors could influence cognitive skills, the spread of knowledge and education background within and across groups. Because cognitive skills and education determine the individual willingness to take risks (e.g., Dohmen, Falk, Huffman & Sunde, 2010; Hardeweg et al., 2013), ethnicity influences the difference in the attitude towards risks across ethnic groups indirectly.

This thesis hypothesizes that cultural factors could shape the difference in risk attitudes and behaviors across ethnic groups in Vietnam. In turn, risk attitudes could explain the probability that different ethnic minority groups adopt the development standards that are based on the

characteristics of the ethnic majority because the more risk-taking people are more likely to adopt new technologies (e.g., Liu & Huang, 2013). Therefore, without taking into account the cultural factors, it is hard to assess the supporting programs because of the mixed effects between the horizontal inequality and the cultural and social factors (e.g., Målqvist et al., 2013). In fact, some small ethnic groups who are less attached to their own cultures have been integrating better and other groups who remain with their own traditions are found less advanced in their integrating process. The cultural and political aspects could be the factors of the minority farmers' decisions to adopt the government's programs (e.g., Bonnin & Turner, 2012; Kyeyune & Turner, 2016). Therefore, it is expectable that cultural factors could explain the ethnic gaps in the case of Vietnam.

Hence, understandings of the role of risk attitudes and education that significantly vary across cultures in determination of agricultural performance could support farmers to improve their living condition. Furthermore, due to the crucial role of agriculture among the ethnic minorities, improving agricultural performance could lead to better position of the ethnic minorities in comparison to the living condition of the ethnic majority. As a result, better agricultural performance potentially results in inclusive development, poverty reduction as well as bridging ethnic disparities.
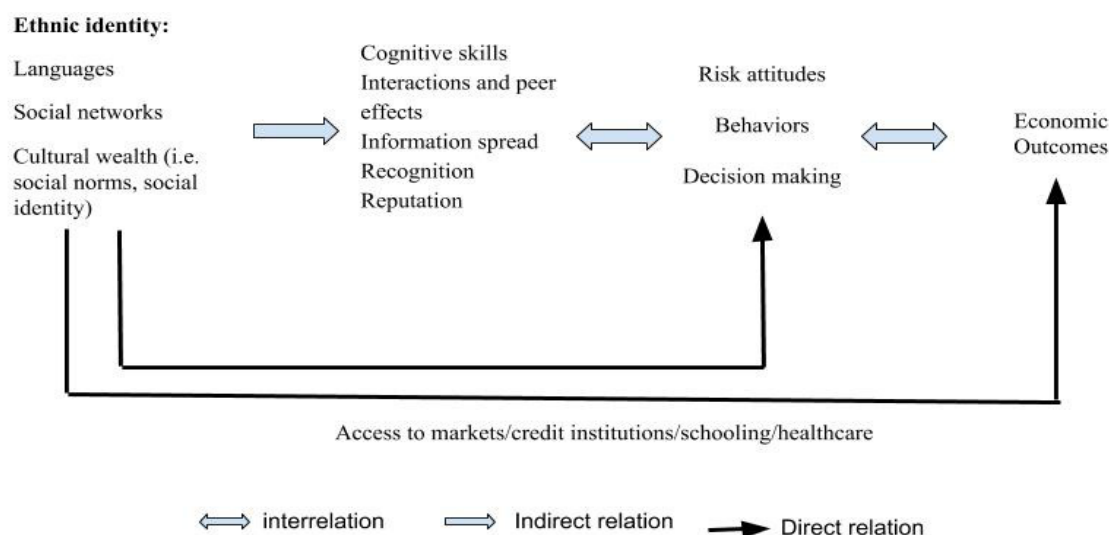
Figure 1.2: Linkage among ethnicity, risk attitudes and economic outcomes

Source: own illustration.

1.3.4 Ethnicity, poverty and inequality

Ethnic diversity has a relationship with poverty in many different ways. Ethnic diversity could influence economic development negatively and indirectly by lessening the social network,

trust and social capital (e.g., Alesina & Zhuravskaya, 2011; Dincer, 2011), in particular, if the agreement across ethnic groups collapses (Miguel & Gugerty, 2005). Indeed, higher social diversity is found to be associated with lower trust (Beugelsdijk & Klasing, 2016). Related to the culturally diverse situation of Vietnamese population, Baulch (2011, p.15) found that the ethnic minorities confront both "hidden and overt discrimination". This "hidden discrimination" is regarding the stereotypes, such as 'ethnic minorities do not know how to make a living, how to use credit effectively, how to use technology or raise livestock they do not consume and have low intellectual levels' (World Bank, 2009). In turn, these stereotypes can have a direct and negative consequence on household welfare regarding access to business opportunities and financial institutions. For instance, this might have affected the limited accessibility to credit (Fafchamps, 1996) and poverty or economic disadvantage among the minorities. Thereby, that it is probably detrimental to the economic circumstances of these groups without presence of well-functioning markets.

Churchill, Okai, and Posso (2016) suggested a direct link between ethnic diversity and poverty. In which, they stated that there is an association between ethnic diversity and persistent poverty due to a hierarchical structure in which the role of the superior belongs to the ethnic majority. Hence, there exists persistent poverty among ethnic minorities in some countries because of the disadvantages that have lasted for long time such as having fewer opportunities and facing discrimination (Epprecht, Müller & Minot, 2011; Gustafsson & Sai, 2009). These negative labels can weaken the self-confidence of the people who are threatened by these misleading preconceptions (Cadinu et al., 2005).

1.4 Research objectives

The main objective of this thesis is to validate the survey-based measure of risk attitudes that could be applied among a large and diverse research sample. Consequently, this thesis examines the complex patterns of the relationship between the risk attitudes and economic welfare accounting for the strong diversity among the subjects. It aims to emphasize the role of risk attitude in the livelihood strategies of the households in particular in agricultural activities that are the main sources of income of the rural households of Vietnam. The specific objectives of each study are outlined in the following.

The first objective is to examine two prominent methods to measure the individual willingness to take risks (i.e. risk attitudes). In particular, we examine the effectiveness of a survey-based instrument to measure risk attitudes among a culturally diverse population. This survey question is widely applied in previous studies. This study examines the extent to which

this survey-based measure could work among people who have different cultural and socioeconomic backgrounds. Hence, this study aims also to address the ethnic dimension of variations in risk attitudes. The diversity is expected however not to deteriorate the power of the survey-based measure of risk attitudes in predicting an incentivized risk experiment. The survey and the experiment were conducted with identical representatives of the households. The study aims to address the heterogeneities of risk attitudes across different ethnic groups. We strengthen the validity of the survey-based measure of risk attitudes by testing its predicting factors for different groups, namely the ethnic majority group and the ethnic minority group.

The second objective is to understand the relationship between risk attitudes and economic outcome in the presence of cultural diversity. This research aims to provide empirical evidence of the patterns of the association between risk attitude and economic welfare by testing the non-linear shape of this relationship when mixing ethnic groups by employing a single-equation estimation method. Furthermore, a simultaneous equation system is applied to investigate the mutual relationship between risk attitudes and economic welfare among a culturally homogenous group of the ethnic majority. In addition, the driving force of cultural factors is examined in the complexity of the relationship between risk attitudes and economic welfare in culturally mixed populations.

The third objective is to understand farmers' knowledge, management skills and risk attitudes by different measurement methods. It examines the relationship among risk attitudes, knowledge, decision-making capacity and farmers' agricultural performance. Particularly, the objective is to answer the following questions. First, do farmers with stronger knowledge and skills show a higher farming performance than those with lower capabilities? Second, it analyzes whether farmers with higher knowledge and skills are also those who are willing to take more risks. Third, it explores if there is a positive relationship between farmers' higher willingness to take risk and their economic success in agricultural production. Because agriculture is the main source of income for the farmers in the research population, this study aims to suggest socioeconomic policies to improve farmers' agricultural productivity via knowledge and risk-taking channels.

1.5 Outline of the thesis

The thesis is composed of three themed chapters from chapter two to chapter four. The overview of these chapters is reported in Table 1.1 below. The brief descriptions of these chapters are summarized as follows.

The second chapter focuses on evaluating the power of a survey question adopted from the German Socio-Economic Panel (SOEP) to capture individual risk attitudes among ethnic groups. The study aims to enhance the survey-based measure by its function among subjects who are culturally and socioeconomically different. The willingness to take risks is compared across ethnic groups and to explore its determinants among the exogenous individual characteristics and account for the living condition and household backgrounds. Additionally, the power of the survey-based individual risk attitudes is tested to predict outcomes of a Holt-Laury type risk experiment. Due to the features of the dependent variable as a categorical variable, the most appropriate regression models are applied such as Interval regression model and Ordered Probit model. At the same time, an Ordinary Least Squares regression is also applied to assess the robustness of the results.

The third chapter explores a complex relationship between risk attitudes and economic welfare in presence of the ethnic diversity. This study seeks to witness that cultural factors drive the variations in risk attitudes and the link between risk attitudes and economic welfare. Both single-equation and system-equation approaches are used to examine the patterns of this relationship from a mixed sample of the ethnic minorities and the ethnically homogenous ethnic majority group. First, the fixed effects model and the correlated random effects model, namely Hausman-Taylor model, are applied to investigate the relationship between risk attitudes and economic welfare using a single-equation estimation method. An ethnically disaggregating analysis is used to examine the difference between the ethnic majority group and the ethnic minority group. Second, a simultaneous estimation method is employed to explore a mutual relationship between risk attitudes and economic welfare using the three Stage Least Squares estimation method.

The fourth chapter investigates the role of risk attitudes and education in decision-making and in agricultural performance. Different methods were used to measure risk attitudes including a survey question, a risk experiment and hypothetical risky investment. Farmers' technical and subjective knowledge as well as cognitive skills with respect to confidence, competence and calculation skills to give precise answers were tested separately for crop production and livestock production. The management decision capacity was measured by decision games in crop and in livestock production separately. Univariate and bivariate analyses are applied to test pairwise the relations between risk attitudes, knowledge, management decision capacity and agricultural performance. Finally, the fifth chapter reports a summary of the thesis and findings. It also concludes and provides recommendations for further research.

Table 1.1: List of essays included in the dissertation

S. No	Title of the Essay	Comments
Essay 1 *(elaborated in chapter 2)*	**Experimentally validated general risk attitude among different ethnic groups in Vietnam** *(addresses objective 1)* Co-authors: *Sabine Liebenehm, Hermann Waibel*	Submitted to Agricultural Economics Earlier versions of this essay were: -TVSEP Working Paper No 004a. https://ideas.repec.org/p/tvs/wpaper/wp-004a.html -Presented at the Annual International Conference of the German Economic Association Research Group on Development Economics, in Göttingen, Germany. June 1-2, 2017. -Presented at CFS Conference on Behavioral Risk Management, Center for Financial Studies, in Frankfurt am Main, Germany. April 14, 2017. -Presented at Doctoral Research Seminar, Research Committee on Development Economics, German Economic Association, in Freiburg, Germany. July 22-23, 2016.
Essay 2 *(elaborated in chapter 3)*	**Do cultural factors alter the relationship between risk attitudes and economic welfare?** *(addresses objective 2)*	Earlier versions of this essay: -TVSEP Working Paper No 003. https://ideas.repec.org/p/tvs/wpaper/wp-003.html -Presented at the 2nd International Conference on Globalization and Development, in Göttingen, Germany. May 3-4, 2018. -Presented in the session on Rural Development at the "Poverty Reduction, Equity and Growth Network" (PEGNet) Conference on "Understanding national inequalities and how to address them", in Zurich, Switzerland. September, 11-12, 2017.
Essay 3 *(elaborated in chapter 4)*	**Farmers' risk attitudes, knowledge, skills and agricultural productivity** *(addresses objective 3)*	Earlier version of this essay: -TVSEP Working Paper No 007. https://ideas.repec.org/p/tvs/wpaper/wp-007.html

Source: Author's illustration

CHAPTER 2

EXPERIMENTALLY VALIDATED GENERAL RISK ATTITUDE AMONG DIFFERENT ETHNIC GROUPS IN VIETNAM

In this chapter, we compare experimentally measured individual risk attitudes and survey-based risk items for rural households in the province of Dak Lak in Southern Vietnam. In particular, we test whether the survey-based measure can be validated by a risk experiment among different ethnic groups. Albeit we find that ethnic minorities are on average more risk averse than the ethnic majority, our results show similar correlations between risk attitudes and socio-economic characteristics among the two ethnic groups. Testing the explanatory power of the survey-based risk item shows the validity of this measure among different ethnic groups. Our findings have potentially important implications. First, the survey-based item is effective to measure risk attitudes of a multiethnic community. Second, our findings also suggest that the assumption of a "self-reinforcing culture of poverty" which is often attributed to the minority groups of Vietnam should be challenged in the light of these results.

2.1 Introduction

The measurement of risk attitudes continues to be controversially discussed in the literature. One group of studies argues that incentivized lottery-choice tasks as for example the typical Holt and Lottery (2002) game conducted in lab- or in lab-in-the-field experiments are preferable as they allow inferring the shape of the utility function (Andersen et al., 2008; Charness et al., 2013). However, experiments are prone to noise depending on the exact elicitation method (Hey et al. 2009; Dulleck et al., 2013) and participant's cognitive ability (Dohmen et al., 2010; Dave et al., 2010; Andersson et al., 2013; Charness & Viceisza, 2015). In addition they are expensive and time-consuming and can, therefore, only be carried out on a relatively small number of respondents.

Survey measures of risk attitudes as advocated by Dohmen et al. (2011) are an economic alternative to experiments and can be easily applied to larger populations in the context of household surveys. On the downside, they are difficult to translate into formal indices and it remains a question if and to what extent they are a reliable predictor of actual risky behavior (Lönnqvist et al., 2015).

A recent review by Chuang and Schechter (2015) substantiates the usefulness of the survey measures. More specifically, empirical investigations by Dohmen et al. (2011) based on the

German Socio-Economic Panel (SOEP) show that simple risk questions are well-associated with results from experiments conducted on the same respondents. Hardeweg et al. (2013) reproduces Dohmen et al.'s (2011) approach using a representative sample from Thailand and confirm the behavioral validity of the survey measure in the context of a developing country. Recently, Vieider et al. (2015) compared students' responses to incentivized lottery choices and survey measures across 30 countries and found significant correlations within most countries and between countries. Based on their findings, they suggest using survey measures for cultural comparisons on risk attitudes.

In this chapter, risk attitudes measured by different methods are examined among the diverse ethnic communities of Vietnam. A representative sample is apart from the population of Dak Lak province that is located in the southern part of Vietnam's Central Highlands. The share of ethnic minorities among the rural population is approximately 30 percent. We test whether the behavioral validity of Dohmen et al.'s (2011) survey-based risk attitude measure also holds among this population and examine ethnic differences in risk attitudes. Some studies claim that Vietnam's ethnic minority people differ in their economic decision-making behavior in comparison to the Kinh majority. This difference in behavior is has been claimed to be a major reason why poverty among ethnic minorities is significantly higher and persists (Montalvo & Reynal-Querol, 2005; Nguyen et al., 2012). Therefore, expected results of this study could shed light on the assumption that there is difference in economic behaviors across ethnic groups. At the same time, we test whether the ethnic minorities in Vietnam are less rational in economic decision-making in comparison with the ethnic majority in respect of the association between risk behaviors in the risk experiment and the risk attitudes.

This chapter has two contributions to the relevant literature. First, we test the validity of the survey-based risk item among a representative sample of rural Vietnam with a risk experiment conducted with the same respondents. This is complementary to the study of Hardeweg et al (2013) that was conducted for a sample in rural Thailand. Second, we compare the validity of the survey risk item between two different groups, i.e. the Kinh majority and a number of ethnic minority groups. In this way we can find out to what extent a simple survey question reflects risk behavior across different cultural groups including people whose decision-making behaviors were assumed to deviate considerably from the *homo oeconomicus* assumption.

The results of our study confirm the usefulness of Dohmen et al.'s (2011) survey measure as a valid instrument to predict risk behavior also among a culturally diverse population such as

the population in Dak Lak, Vietnam. The experimental validity of the survey item can also be confirmed for different ethnic groups. We find no evidence that ethnic minority groups behave less consistently in risk experiments and to the survey risk question when compared to the Kinh majority group.

The remainder of this chapter is organized as follows. In the next section we describe the sample and provide some descriptive statistics. In section 3 we present the results, first, using the full sample and second, using the two sub-samples of the ethnic minorities and the Kinh majority. Finally, in section 4 we conclude and submit recommendations for further studies.

2.2 Data

2.2.1 Sample population

Dak Lak province is located in the southern tip of the Central Highlands of Vietnam with approximately 13,000km² and a population of 1.8 million people. Agriculture is the major source of income with coffee as the main commodity. The rural population is characterized by a large number of different ethnic minority groups such as Ede, M'nong, Thai, Tay or Nung - accounting for approximately 30 percent of the population which is well represented in our sample of some 700 respondents.

The data set was collected as part of a long-term socio-economic panel (TVSEP) that has been implemented in six provinces in Thailand and Vietnam since 2007. The initial sample composed of 4,400 households in 440 villages (Klasen & Waibel, 2013). The sample was selected based on a stratified three stages sampling procedure whereby the province (in our case Dak Lak) was purposively chosen. Due to the large heterogeneity in population density the province was subdivided into two agro-ecological zones, namely the lowland and the mountain zones. Within both zones, communes were selected according to the weight of rural population shares. In the second stage, villages were chosen by the probability proportional to the population size. Finally, ten households were randomly selected in each village[1]. In this study, we use the survey wave from 2010 of Dak Lak province.

The comprehensive survey instrument included detailed modules on household and individual characteristics, income, consumption and assets as well as shocks and risks. We also included Dohmen et al.'s (2011) survey-based risk item, where respondents are asked to classify

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[1]Owning to sampling procedure, the sample is not self-weighting which was considered in the regression analyses.

themselves on an eleven-point Likert scale to answer the question: "Are you generally a person who is fully prepared to take risks, or do you try to avoid taking risks? Please choose a number on a scale from zero (unwilling to take risks) to ten (fully prepared to take risks)".

Upon completion of the interview, respondents were offered to join a Holt and Laury (2002) type of risk experiment. In brief, the respondent was confronted with 20 choices between a safe payoff and a lottery. To illustrate the choices to the respondent a table with 20 rows was used. Starting with row 1, the participant was asked for each subsequent row in ascending order whether she would prefer to receive the safe payoff or to play a lottery in which the payoff could be either VND 0 or VND 200,000 with 50 percent probability. The expected value is above a full day's salary and therefore is believed to provide sufficient incentive. The participant was informed in advance that, after the 20 choices had been noted, a random number between 1 and 20 would determine which of the 20 choices was to be played with real payoffs. The risk experiment follows the procedure applied with households in the province of Ubon Ratchathani in Thailand as described by Hardeweg et al. (2013).

Preferring the safe payoff at lower row numbers (below row 16) implies higher risk aversion; choosing the safe payoff of VND 150,000 versus the VND 0 or VND 300,000 lottery (row 16) implies risk neutrality, whereas preferring the lottery at rows 17–20 corresponds to risk-loving behavior. The row in which the respondent's preference switched from the lottery to the safe amount gives an indication about the respondent's risk attitude. To assure that the incentive reveals actual preferences, a number between 1 and 20 was drawn randomly after the respondent had made her choices. In case the number drawn was below the respondent's switch point the lottery would be played by tossing a coin. If the random number was higher than the switch point, the respondent received the safe amount.

Out of 701 respondents 11 refused to participate in the experiment. Furthermore, we excluded the respondents who were younger than 16 and older than 80 years old resulting in a final sample of 679 observations. Out of the 679 respondents, over one third (37.5 percent) are ethnic minorities while the remainder belong to the Kinh majority group.

2.2.2 Descriptive statistics

We report in Table 2.1 the summary statistics of respondents' socio-economic characteristics that are the variables used in our econometric analyses. An average household size is 5.51 members. Respondents are on average in their mid-forties, the share of female respondents is 46 percent and the vast majority is married. The average dependency ratio is 59 percent,

which underlines that most households are in advanced age. More than half of the respondents are members of a village organization. Engagement in self-employment like small scale businesses is infrequent with 15 percent of households.

The residential house is the major asset of respondents' household with an average value of 7,700 USD PPP which is the most important asset aside from land which however is normally not privately owned in Vietnam.

In terms of self-assessed health conditions majority of the respondents consider themselves to be healthy. When asked about the future well-being respondents are slightly optimistic with an average score of 0.33 albeit with high standard deviation.

For the survey risk item average scale was 3.09 on the 11-point Likert scale, which indicates a relatively low willingness to take risk. The average switching row in the risk experiment was 8.28 which confirms the survey-based measure as of is in the moderately risk averse region. This is slightly lower for the survey risk item and slightly higher for the switching row as in the results of Hardeweg et al. (2013) for a similar population in Thailand.

Table 2.1: Descriptive statistics

Variable Name	Variable Definition	N	Mean	SD
Household size	The number of persons who belong to the household and stayed at least 180 day during the reference period	679	5.51	1.99
Age	Age of respondent in years	679	44.45	12.21
Height	Height of respondent in cm	679	159.28	6.88
Education	Years of schooling of respondent	678	6.49	3.85
Gender	Dummy Variable; Female = 1	679	0.46	-
Civil Status	Dummy Variable for civil status; married = 1	679	0.88	-
Dependency ratio	Ratio of the number of resident household members below 15 and above 64 years old	673	0.59	0.58
Membership	Dummy Variable for respondent's membership of a social or political organization; member = 1	679	0.56	0.50
Self-employed	Dummy Variable if the respondent's 1st or 2nd occupation is self-employment (yes = 1)	679	0.15	0.36
Ethnicity	Dummy Variable; Ethnic Majority = 1	679	0.62	-
House value	Self-reported house value at market price (in USD PPP)	678	7700	12718
Health impairment	Dummy Variable if the respondent considers himself to be unhealthy (yes= 1)	679	0.25	0.43
Optimism	Respondent's subjective assessment of well-being on a scale from -2 (much worse) to 2 (much better)	654	0.33	0.64
Willingness to take risk (WTR)	General willingness to take risk , based on survey question	679	3.09	2.72
Switching Row (SR)	The row number of the risk experiment where the respondent switched from game to safe amount	679	8.28	5.21

Source: TVSEP survey 2010, own calculations

Figure 2.1 shows the distribution of the survey risk item. Clearly, the distribution is skewed to the right that indicates that most of the respondents have low level of willingness to take risk.

Almost one third of the respondents are extremely risk averse as they opted for a zero value on the scale. Less than 10 percent show high willingness to take risk with a value of 8 and above on the 11-point Likert scale.
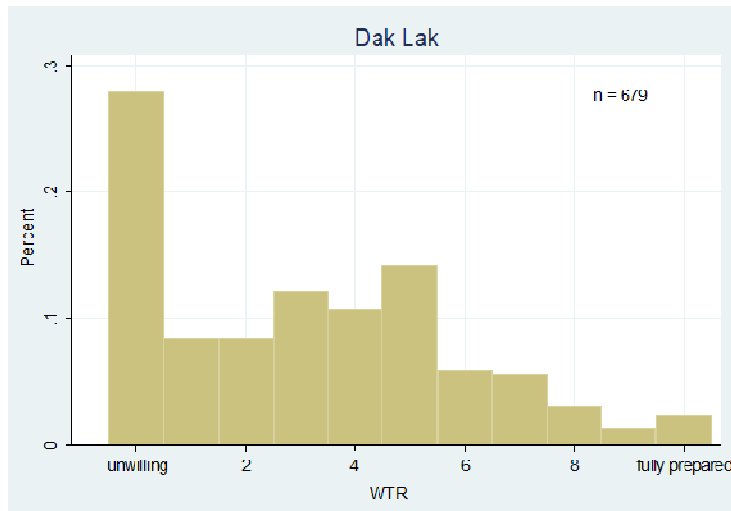
Figure 2.1: Self-reported willingness to take risk, full sample

Note: WTR: Willingness to take risks
Source: TVSEP survey 2010, own calculations

Figure 2.2 plots the distribution of switching rows from the lottery to the safe amount in the risk experiment. The majority of respondents switched before row 15, which confirms the general tendency of risk averse behavior which is mostly found among poor rural households in developing countries (Haushofer & Fehr, 2014) including Vietnam (Tanaka et al., 2010).
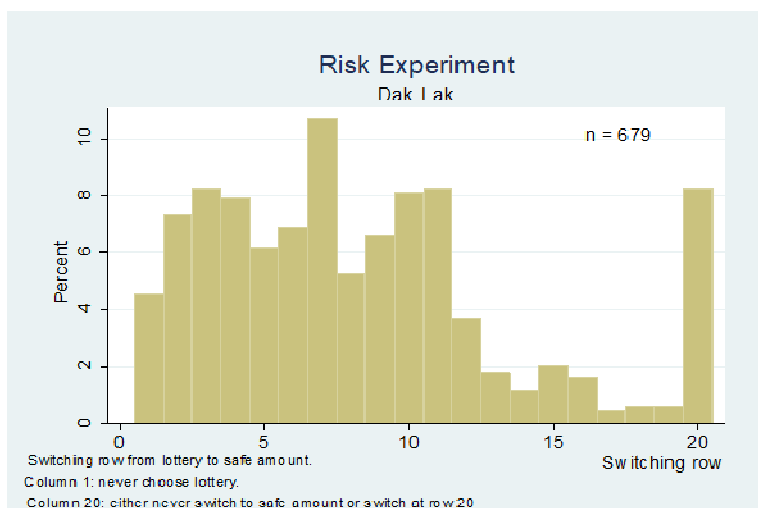
Figure 2.2: Switching row in risk experiment, full sample

Source: TVSEP survey 2010, own calculations

To explore the association between the survey-based item and the experiment we plot the WTR values against the switching rows (SR) for every value on the 11-point Likert scale (Figure 2.3). Generally, the means values of SR tend to go up as WTR values increase.

However, for the low WTR (i.e. below five) values, the SR means are below and are mostly above the average of SR for the WTR values above five. The standard deviation values seem reasonable as they are lower than their means and remain fairly constant over the WTR range. Hence we have reason to assume that there is some significant correlation between the two measures of risk attitudes.
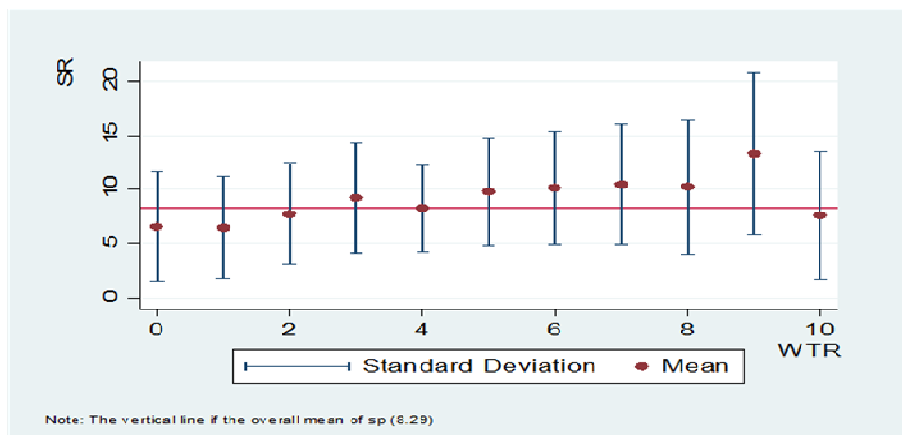
Figure 2.3: Mean and standard deviation comparison between SR and WTR

Source: TVSEP survey 2010, own calculations

2.3 Results

In order to test the behavioral validity of the survey measure among the culturally diverse population in Dak Lak, we proceed in two steps. First, we take the full sample and investigate the correlations between the survey measure and socio-demographic characteristics and test whether the survey measure is correlated with the outcome of the experiment. Second, we split the sample into two groups, namely the ethnic minorities and the Kinh majority, and repeat the analyses separately among the two sub-samples.

2.3.1 Full sample

Table 2.2 shows five alternative specifications of regression models with respondents' self-assessed risk attitude (WTR) as dependent variable. As a first specification (Table 2.2, column 1), we only consider the most exogenous individual characteristics such as gender, age, height, education, civil status and ethnicity as explanatory variables. Many studies suggest that being female, older and smaller is positively associated with risk aversion (e.g. Eckel & Grossman, 2008; Dohmen et al., 2011; Hardeweg et al., 2013; Nielsen et al., 2013; Sunde & Dohmen, 2016). The significant positive correlation coefficients on respondents' height and ethnicity confirm our expectations. More specifically, the respondents who belong to the ethnic majority in Vietnam are associated with lower levels of risk aversion.

In the second specification (Table 2.2, column 2) we include the variable house value to reflect respondents' economic status meanwhile remaining the group of variables in the first specification. Many studies suggest that risk aversion should decline in wealth (e.g., Dohmen et al., 2011; Guiso & Paiella, 2008; Yesuf & Bluffstone, 2009). Other studies, however, do not find a significant relationship (e.g., Binswanger, 1980; Tanaka et al., 2010) and some even find a positive correlation (e.g., Harrison et al., 2007; Liu, 2013; Vieider et al., 2013). With the positive significant correlation coefficient on house value, we correspond to the first strand of studies and find that risk aversion is negatively associated with wealth.

In the third specification (Table 2.2, column 3) we add three groups of variables, i.e. (i) respondents' household characteristics (ii) respondents' employment status and (iii) respondents' subjective attitudes. With respect to the first group of variables, the literature suggests that being married and living in larger households with a higher dependency ratio is positively associated with risk aversion. This was found, for example, by Skriabikova et al. (2014) using data from Ukraine, by Caliendo et al. (2009) using the German SOEP and by Hardeweg et al. (2013) in Thailand. The latter study also found that rural household members who engage in self-employment for example through small-scale village businesses are prepared to take more risk than those who earn their living from farming or wage employment (Hardeweg et al., 2013). Hence, for our Vietnam sample we expect a positive correlation between self-employment and respondents' WTR. Furthermore, being a member of a socio-political organization (mostly village committees) puts a household in a better position to share risk with others. Therefore, we expect a positive association between membership and willingness to take risk. For variables like the respondents' health impairment, we expect a negative sign and for and expectations about the future, we expect a positive association with WTR. Among the three variable groups, we obtain four significant correlation coefficients that confirm our expectations. The correlation coefficient between WTR and household size is significant and negative. Generally, poorer households and those engaged more subsistence-type of agriculture tend to have more children and thus tend to be more risk-averse. Membership in village organizations is positively associated with respondents' willingness to take risk i.e. respondents are willing to take more risk because they tend to have better social protection and better access to information and new technologies. Furthermore, respondents who feel healthier and who are more optimistic about the future are more willing to take risk.

Contrary to most findings in the literature, age is positively correlated with the willingness to take risk. For Vietnam, a possible explanation is that older people belong to the "war

generation" who were conditioned to take more risk than younger people who did not have this experience. However, this correlation is rather weak and less robust across specifications.

Specifying model (3) as an ordered probit model (Table 2.2, column 4) or as an OLS model (Table 2.2, column 5) confirms the correlation results. All coefficients which are found significant in the third specification remain consistent both in terms of sign and significance.

Table 2.2: Multivariate correlates of the survey-based willingness to take risk (WTR), full sample

	(1)	(2)	(3)	(4)	(5)
Gender	0.220	0.261	0.251	0.089	0.196
	[0.380]	[0.371]	[0.348]	[0.120]	[0.262]
Age (years)	0.012	0.005	0.022**	0.008**	0.019**
	[0.011]	[0.010]	[0.010]	[0.004]	[0.007]
Height (cm)	0.062**	0.057**	0.053**	0.019**	0.037**
	[0.029]	[0.027]	[0.026]	[0.009]	[0.018]
Ethnicity	1.571***	1.171***	0.783***	0.275***	0.589***
	[0.295]	[0.298]	[0.269]	[0.092]	[0.203]
Civil Status	0.639	0.418	0.450	0.151	0.356
	[0.518]	[0.493]	[0.442]	[0.150]	[0.316]
Education (years)	0.173***	0.135***	0.071**	0.025**	0.055**
	[0.032]	[0.030]	[0.030]	[0.011]	[0.023]
House value (ln)		0.648***	0.586***	0.202***	0.469***
		[0.116]	[0.114]	[0.040]	[0.090]
Dependency ratio			-0.207	-0.078	-0.184
			[0.200]	[0.068]	[0.151]
Household size			-0.185**	-0.063**	-0.144***
			[0.075]	[0.025]	[0.052]
Self-employed			0.165	0.060	0.110
			[0.300]	[0.106]	[0.250]
Membership			1.032***	0.358***	0.752***
			[0.211]	[0.074]	[0.167]
Health impairment			-0.881***	-0.296***	-0.685***
			[0.311]	[0.106]	[0.213]
Optimism			0.894***	0.309***	0.704***
			[0.240]	[0.085]	[0.181]
Constant	-11.075**	-14.424***	-12.991***		-8.189**
	[4.544]	[4.536]	[4.456]		[3.099]
Ln sigma	1.154***	1.118***	1.061***		
	[0.044]	[0.043]	[0.044]		
Log likelihood	-1419.616	-1393.271	-1299.456	-1284.269	
Pseudo R^2	0.025	0.043	0.066	0.066	0.247
Observations	679	678	646	646	646

Note: Dependent variable is the general willingness to take risks. Columns 1-3 report Interval Regression estimates of the self-reported willingness to take risk on an 11-point Likert scale. Column 4 reports Ordered Probit estimates and column 5 reports Ordinary Least Squares estimates. All specifications take into account the complex sampling design and standard errors in brackets.
Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Source: TVSEP survey 2010, own calculations

In Table 2.3, we perform the same multivariate analysis for the results of the incentivized field experiment (conducted with the same respondents) as we did for the survey-based item in Table 2.2. The purpose of this comparison is to test the validity of both measures for the data set of the rural population of Dak Lak province. Accordingly, this would be the case if

the control variables show similar direction of influence and similar statistical performance for both dependent variables. In addition, we are interested in the direct correlation between both measures of risk attitude.

In column (1) of Table 2.3 we simply include the survey item as a single covariate and find a highly significant correlation coefficient. A change by one unit on the Likert-scale is accompanied by a change in the experiment by more than 0.5 rows. The relationship and its magnitude do not fundamentally change as we include additional variables. Controlling for other individual characteristics such as gender, age, height or ethnicity in column 2, decreases the coefficient on the survey measure, it remains significant at the 1 percent level. At the same time, the same control variables as in Table 2.2, i.e., height and ethnicity are statistically significant. This result holds when further variables are added in columns 3 and 4 and different regression models are used in columns 5 and 6. The survey-based item, hence, remains as a significant predictor of the outcome of the experiment.

Similarly, we compare the results of the correlation analysis presented in Table 2.3 with those of a rural population in Thailand (Hardeweg et al., 2013). We find that the behavioral validity of the survey measure that was found for Thai population also holds for Vietnamese. Differences in the levels of economic development history and in the political system between two countries do not seem matter. The distinguishable finding for Vietnamese population is that in Vietnam, ethnicity must be considered. However, it is not a factor in the rather culturally homogenous population of Northeast Thailand. Therefore, in the next sub-section we will explore the role of ethnicity further.

Table 2.3: Multivariate correlates of the switching row in the risk experiment (SR), full sample

Variables/Model variant:	(1)	(2)	(3)	(4)	(5)	(6)
WTR	0.553***	0.401***	0.388***	0.317***	0.065***	0.284***
	[0.099]	[0.096]	[0.106]	[0.100]	[0.021]	[0.092]
Gender		0.240	0.253	0.184	0.056	0.139
		[0.613]	[0.621]	[0.648]	[0.115]	[0.588]
Age		-0.025	-0.025	-0.003	-0.001	0.000
		[0.022]	[0.022]	[0.020]	[0.004]	[0.018]
Height		0.071**	0.072**	0.073**	0.014**	0.070**
		[0.034]	[0.034]	[0.032]	[0.006]	[0.029]
Ethnicity		1.779***	1.727***	1.281***	0.234**	1.174***
		[0.433]	[0.449]	[0.441]	[0.086]	[0.398]
Civil Status		-0.572	-0.596	-0.451	-0.064	-0.429
		[0.651]	[0.635]	[0.695]	[0.116]	[0.605]
Education		0.131**	0.130**	0.113*	0.015	0.099
		[0.060]	[0.060]	[0.066]	[0.014]	[0.060]
House value			0.089	-0.033	-0.012	-0.040
			[0.220]	[0.242]	[0.047]	[0.213]
Dependency ratio				-0.311	-0.065	-0.275
				[0.412]	[0.074]	[0.364]
Household size				-0.038	-0.011	-0.031
				[0.124]	[0.026]	[0.107]
Self-employed				2.065***	0.371***	1.924***
				[0.505]	[0.091]	[0.448]
Membership				0.237	0.058	0.189
				[0.454]	[0.084]	[0.409]
Health impairment				-1.454***	-0.281***	-1.372***
				[0.444]	[0.089]	[0.410]
Optimism				0.470	0.116*	0.417
				[0.353]	[0.066]	[0.317]
Constant	6.105***	-5.248	-5.954	-5.332		-4.277
	[0.427]	[5.665]	[5.979]	[5.990]		[5.406]
Ln sigma	1.708***	1.684***	1.685***	1.679***		
	[0.042]	[0.041]	[0.041]	[0.043]		
Log likelihood	-1965.430	-1946.946	-1944.118	-1848.144	-1729.952	
Pseudo R^2	0.012	0.020	0.020	0.024	0.026	0.135
Observations	679	679	678	646	646	646

Note: Dependent variable is switching row (SR) in the experiment. Columns (1- 4) report Interval Regression estimates of the switching row in the experiment. Column 5 reports Order Probit regression estimates and column 6 reports Ordinary Least Squares estimates. All specifications take into account the complex sampling design and standard errors in brackets. House value is self-reported at current market price.
Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$
Source: TVSEP survey 2010, own calculations

2.3.2 Comparison between ethnicities

In this section, we investigate if the survey-based risk item can predict the outcome of the experiment among different ethnicities in Vietnam. More specifically, we examine the difference between the majority of Kinh ethnic group and the group of various ethnic minorities.

In the first step, we investigate differences in means of observable characteristics between the two ethnic groups (Table 2.4). Most importantly, we notice that the ethnic minorities are less willing to take risk based on the WTR as well as on the SR measure. Moreover, the ethnic

minorities are significantly younger by about 5 years on average but are significantly less educated with about 3 years of schooling. On the other hand, the ethnic minority families on average are significantly larger by 0.7 household members and households show a significantly higher dependency ratio. Among the ethnic minorities, self-employment is rare with less than 5 percent against 21 percent of the Kinh majority. The ethnic minorities significantly less frequent are members of socio-political organizations. The above-described differences that we find when comparing the ethnic groups in our sample corresponds well with the finding in relevant studies in Vietnam (e.g., Vu & Baulch, 2011; Imai et al., 2011; Kang & Imai, 2012). In addition, the members of the ethnic minority are also significantly less optimistic towards the future as they self-reported.

Table 2.4: Differences in observable characteristics between Ethnic minority groups and the ethnic majority

	Ethnic minorities		Ethnic majority		Difference in means
	Mean	SD	Mean	SD	
WTR	2.067	2.26	3.712	2.79	-1.645***[c]
SR	6.729	6.73	9.208	5.41	-2.479***[c]
Gender	0.463	0.03	0.458	0.02	0.005[a]
Age	41.835	12.78	46.028	11.6	-4.193***[b]
Height	158.969	6.37	159.465	7.17	-0.496[b]
House value	3717	306.58	10085	735.55	-6367***[b]
Education	4.709	3.92	7.561	3.38	-2.853***[b]
Dependency ratio	0.701	0.6	0.527	0.56	0.174***[b]
Household size	5.984	2.38	5.231	1.64	0.753***[b]
Civil Status	0.863	0.02	0.887	0.02	-0.024[a]
Self-employed	0.047	0.01	0.215	0.02	-0.168***[a]
Membership	0.463	0.03	0.611	0.02	-0.325***[a]
Health impairment	0.239	0.43	0.252	0.43	-0.013[a]
Optimism	0.204	0.62	0.408	0.64	-0.204***[c]
N	255		424		

Note: [a]prtest (test for the same proportion between two groups) is used for dummy variables; [b]t-test. [c]Chi square test. Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$
Source: TVSEP survey 2010, own calculations

In a next step, we analyze the correlations between the survey-based risk item and observable characteristics among the two ethnic groups following the procedure applied to the full sample. We, however, limit the analysis to three regression models including all explanatory variables as for the full sample including interval regression, ordered-probit and OLS. Columns (1), (2) and (3) of Table 2.5 show the results for the majority group and columns (4), (5) and (6) show results for the minorities.

Results for the Kinh majority are reported in the first three columns of Table 2.5 that are similar to the results for the full sample presented in Table 2.2. This is not surprising since almost 60 percent of the full sample belong to this ethnic majority group. More specifically, six out of eight significant variables (excluding the ethnicity variable) in the full sample

remain in this reduced sample. However, two variables, namely height and education, turn insignificant in the majority sample (Table 2.5). Interestingly, we find that the variable dependency ratio that was insignificant in the full sample turns significant in the majority sample. The correlation coefficient is negative suggesting that a higher share of economically inactive (dependent) people in the household will tend to make decision makers in the majority group slightly more risk-averse. That seems plausible because fewer people who have probably higher financial responsibility that reduces their willingness to jeopardize by taking risks into their economic decisions.

Applying the same models for the ethnic minorities results the outputs in columns 4-6 of Table 2.5. The results show three significant correlation coefficients that are similar in sign and magnitude in comparison with that of the Kinh majority sample (columns 1-3 of Table 2.5) and in the full sample (Table 2.2). Among those three coefficients are: (i) house value as an indicator for wealth, (ii) being a member of a socio-political organization and (iii) being optimistic about the future. In particular, those minority respondents who are wealthier, who belong to socio-political organizations and who are more optimistic towards their future wellbeing are more willing to take risks. Furthermore, the two variables that were insignificant in the majority sample, namely height and education, turn significant in the minority sample as that of the full sample.

Although there is smaller number of significant correlations found in the minority sample, the consistency in the common significant predictors in sign and magnitude in comparison between the two ethnic groups indicates to some extent the robustness of the survey-based risk item measure to reveal individual risk attitudes across ethnic groups.

Table 2.5: Multivariate correlates of the survey-based willingness to take risk (WTR), separate estimation by ethnic groups

Model variant:	(1)	(2)	(3)	(4)	(5)	(6)
Variables/group	Ethnic majority (Kinh)			Ethnic minorities		
Gender	-0.006	-0.002	0.035	0.684	0.261	0.426
	[0.453]	[0.155]	[0.374]	[0.569]	[0.210]	[0.359]
Age	0.031**	0.011**	0.026**	0.011	0.004	0.011
	[0.012]	[0.004]	[0.010]	[0.020]	[0.007]	[0.013]
Height	0.035	0.012	0.027	0.096**	0.037**	0.061**
	[0.031]	[0.010]	[0.023]	[0.038]	[0.014]	[0.022]
House value	0.653***	0.221***	0.547***	0.407**	0.153**	0.286**
	[0.132]	[0.045]	[0.108]	[0.183]	[0.068]	[0.126]
Education	0.019	0.008	0.016	0.132***	0.051***	0.099***
	[0.036]	[0.013]	[0.030]	[0.044]	[0.016]	[0.033]
Civil Status	0.603	0.200	0.457	0.197	0.053	0.127
	[0.581]	[0.194]	[0.440]	[0.728]	[0.271]	[0.477]
Dependency	-0.535**	-0.188**	-0.485**	0.260	0.094	0.232
Ratio	[0.233]	[0.078]	[0.186]	[0.272]	[0.098]	[0.176]
Household size	-0.219*	-0.076**	-0.195**	-0.129	-0.043	-0.087
	[0.110]	[0.036]	[0.088]	[0.097]	[0.037]	[0.063]
Self-employed	0.163	0.057	0.116	0.709	0.287	0.543
	[0.343]	[0.117]	[0.282]	[0.750]	[0.282]	[0.603]
Membership	1.141***	0.383***	0.887***	0.935***	0.367***	0.637***
	[0.282]	[0.096]	[0.225]	[0.300]	[0.115]	[0.204]
Health	-0.904***	-0.302***	-0.756***	-0.697	-0.238	-0.420
Impairment	[0.326]	[0.108]	[0.245]	[0.550]	[0.205]	[0.314]
Optimism	0.800***	0.271***	0.657***	1.188**	0.451**	0.924***
	[0.241]	[0.082]	[0.190]	[0.436]	[0.179]	[0.331]
Constant	-9.519*		-6.297	-18.851**		-11.009**
	[5.185]		[3.874]	[6.966]		[4.186]
Ln sigma	1.078***			0.981***		
	[0.053]			[0.061]		
Log likelihood	-878.135	-864.468		-414.300	-407.491	
Pseudo R^2	0.046	0.046	0.188	0.065	0.067	0.228
Observations	409	409	409	237	237	237

Note: Dependent variable is the general willingness to take risks. Columns (1) and (4) report the Interval Regression estimations of the self-reported willingness to take risk. Columns (2) and (5) report Order Probit regression estimates and columns (3) and (6) report Ordinary Least Squares regression estimates. All specifications take the complex sampling design into account and standard errors in brackets.
Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.
Source: TVSEP survey 2010, own calculations

In the next step, we verify whether the survey-based risk measure item can predict the outcome of the experimental measure among different ethnic groups. We include the WTR measure as a predictor in the multivariate analysis of the SR, separately for both ethnic groups. Table 2.6 shows the regression results, of the same three equations for both groups.

Columns 1-3 of Table 2.6 show that the same variables are significant for the majority sample as for the full sample presented in Table 2.3. In other words, results among the Kinh majority are consistent with the full model. However, results for the minority sample are different, i.e. only three significant correlation coefficients remain. These are the coefficients of WTR, of health impairment (columns 4-6 in Table 2.6) and of the variable age (columns 4 and 6 only). Comparing the magnitude of the correlation coefficient of the variable WTR between the ethnic majority subsample (column 3 in Table 2.6) and the ethnic minority subsample

(column 6 in Table 2.6) shows that the coefficient is larger in the ethnic minority subsample. Specifically, a change by one unit in the self-assessed risk attitude is associated with a change in the experiment by approximately 0.2 rows in the majority group and by approximately 0.6 rows in the minority group. Across alternative specifications, the self-assessed risk attitude measure remains a strongly significant correlate of the switching row in the experiment among the minority sample. Hence, we can conclude that the survey-based risk item is well-validated by the risk experiment even among a mixed sample of different ethnic groups. It can equally be applied to ethical minority groups who differ significantly in socio- economic characteristics from the Kinh majority in Vietnam.

Table 2.6: Multivariate correlates of the switching row in the risk experiment (SR), separate estimation by ethnic groups

Model variant:	(1)	(2)	(3)	(4)	(5)	(6)
Variables/group	Ethnic majority			Ethnic minorities		
WTR	0.217*	0.039*	0.183*	0.646***	0.158***	0.607***
	[0.114]	[0.021]	[0.102]	[0.123]	[0.030]	[0.116]
Female	0.102	0.038	0.096	0.291	0.078	0.199
	[0.900]	[0.146]	[0.808]	[0.872]	[0.192]	[0.804]
Age	-0.031	-0.004	-0.022	0.039*	0.007	0.037*
	[0.032]	[0.006]	[0.028]	[0.022]	[0.006]	[0.021]
Height	0.077*	0.014*	0.074*	0.045	0.008	0.044
	[0.043]	[0.007]	[0.039]	[0.047]	[0.011]	[0.043]
House value	-0.005	-0.005	0.004	-0.002	-0.009	-0.032
	[0.292]	[0.054]	[0.253]	[0.312]	[0.074]	[0.286]
Education	0.152*	0.017	0.128*	0.062	0.010	0.054
	[0.083]	[0.017]	[0.073]	[0.089]	[0.021]	[0.084]
Married	-1.015	-0.122	-0.812	0.286	0.074	0.128
	[1.095]	[0.157]	[0.945]	[0.904]	[0.203]	[0.835]
Dependency ratio	-0.465	-0.071	-0.444	-0.132	-0.084	-0.080
	[0.494]	[0.084]	[0.458]	[0.585]	[0.129]	[0.486]
Household size	0.031	0.005	0.014	-0.128	-0.032	-0.107
	[0.224]	[0.040]	[0.190]	[0.155]	[0.038]	[0.141]
Self-employed	2.427***	0.415***	2.209***	-0.389	-0.058	-0.250
	[0.594]	[0.095]	[0.514]	[1.244]	[0.339]	[1.138]
Membership	0.491	0.097	0.433	-0.298	-0.034	-0.314
	[0.565]	[0.099]	[0.498]	[0.616]	[0.141]	[0.562]
Health Impairment	-1.364**	-0.246**	-1.271**	-1.609**	-0.372**	-1.539**
	[0.585]	[0.104]	[0.520]	[0.625]	[0.160]	[0.588]
Optimism	0.413	0.119	0.385	0.109	0.026	0.073
	[0.501]	[0.090]	[0.447]	[0.558]	[0.116]	[0.517]
Constant	-3.558		-2.934	-3.179		-2.072
	[8.252]		[7.312]	[8.041]		[7.343]
Ln sigma	1.761***			1.482***		
	[0.044]			[0.072]		
Log likelihood	-1184.68	-1103.31		-648.69	-603.04	
Pseudo R^2	0.016	0.017	0.093	0.028	0.033	0.148
Observations	409	409	409	237	237	237

Note: Dependent variable is switching row in the risk experiment. Columns (1) and (4) report the Interval Regression estimates of the switching row in the experiment. Columns (2) and (5) report Order Probit regression estimates and columns (3) and (6) report Ordinary Least Squares regression estimates. All specifications take the complex sampling design into account and standard errors in brackets.
Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Source: TVSEP survey 2010, own calculations

2.4 Summary and conclusions

In this study, we test the behavioral validity of the widely known survey-based measure of risk attitudes as initially suggested by Dohmen et al. (2011) among the culturally diverse rural populations in the province of Dak Lak, Vietnam. To do so, we use a representative sample of 679 respondents who are heads or representatives of rural households. We conduct comprehensive household interviews in 2010 that include the survey risk item that was followed by a Holt and Laury's (2002) type of "lab-in-the-field" experiment for the same respondents. This data enable us to apply a multivariate regression method to estimate the correlations between both risk measures and a set of socio-demographic characteristics known to be determinants and predictor of individual risk attitudes. We further examine if the survey-based risk measure can predict the outcome of the risk experiment. Most importantly, since our sample consisted of two main ethnic groups, namely the Kinh majority group and a group of several ethnic minorities we apply this estimation approach among the full sample and separately for the ethnic majority and ethnic minorities.

Our results show that the minority group expressed a higher degree of risk aversion than the respondents of the majority group did. We can also show that both groups differ significantly in several individual and household characteristics including economic wellbeing. We find that many of the hypothesized variables were significantly correlated with the survey-based and the experiment-based risk measure for both groups. Our major result is that we find the survey measure to be a significant predictor of the experiment not only for the majority group but also for the ethnic minorities. The results remain robust across different regression models and specifications. Therefore, we conclude that Dohmen et al.'s (2011) survey measure is a valid instrument to predict risk behavior among a culturally diverse population. This does not mean that the survey-based measures are complete substitutes of experimental measures rather are they complements (Chuang & Schechter, 2015). For example, experimental measures continue to be needed in the context adoption studies for new and complex technologies where loss-averse behavior is relevant (Liu & Huang, 2013) and for in-depth studies on behavioral characteristics of decision-makers (Liebenehm & Waibel, 2014). On the other hand survey risk measure widens the scope for empirical research that depends on large scale panel data.

The results of this empirical study submit two potentially important policy conclusions. First, we confirm the results found by Hardeweg et al (2013) for a rural population in Thailand for similar conditions in Vietnam. Therefore, with a second in-depth study from real world

decision makers in developing countries we confirm that the simple survey-based measure of risk attitudes, which has been widely used in developed countries, can also be well applied in developing countries. This can help improve the understanding of decision-making and welfare dynamics of rural households in emerging market economies when simple risk measures are routinely included in socio-economic and living standard surveys. Certainly, care must be taken to make sure that the survey risk question is properly asked. Second, the Based on the results, we confirm that survey risk questions and risk experiments can be carried out successfully with ethnic minority groups in Vietnam. This finding is interesting because ethnic minorities, aside from being poorer and less educated, are often also labeled with following behavioral patterns which are different from the rational decision makers of the Kinh majority in Vietnam and therefore to a "self-reinforcing culture of poverty" has been attributed to ethnic minority groups (van der Walle & Gunewardena, 2001). Our results, however, do not confirm any evidence of the irrational behaviors among the ethnic minorities since the same survey risk item and the same risk experiment can be equally well applied and well correlated for both groups. Therefore, our results have some relevance to the anti-poverty-programs of the Vietnamese government. In particular, our results suggest that they should be better treated equally with other disadvantaged ethnic majority groups.

CHAPTER 3

DO CULTURAL FACTORS ALTER THE RELATIONSHIP BETWEEN RISK ATTITUDES AND ECONOMIC WELFARE?

This chapter analyzes how cultural factors shape risk attitudes and subsequently alter its relationship with economic welfare. The research sample is comprised by a three wave balanced panel data set of 588 ethnically diverse households collected between 2008 and 2013 in the Central Vietnam. Different ethnic groups are characterized by different languages, customs and beliefs that create the cultural diversity of the sample. Different approaches are used to examine the relationship between risk attitudes and economic welfare in the presence of the cultural diversity. First, a single-equation estimation method using a fixed effects model and a Hausman-Taylor model is employed to examine the unidirectional relationship. Second, a simultaneous equation estimation method using the Three Stage Least Squares model is applied to explore a bidirectional relationship between risk attitudes and economic welfare. Among the ethnic minorities, results indicate a negative association between willingness to take risks and economic welfare at low degree but a positive at the higher degree of risk-taking. For the ethnic majority, a positive and mutual relationship between risk attitudes and economic welfare is indicated. The ethnic majority is economically better-off than their minority counterparts are, whereas the minorities are economically homogenous but strongly diverse in risk attitudes and social factors. This study sheds light on the cultural heterogeneity in the individual risk attitudes as well as in shaping its relationship with economic welfare. Generally, it is suggested to consider socio-cultural factors via risk-taking channel in socioeconomic policies that target ethnically or culturally diverse populations. Particularly, that implies a need to encourage the risk-taking strategies among the extremely risk-averse individuals, particularly who belong to the ethnic minorities.

3.1 Introduction

Poverty or financial difficulties in general can lead to risk-averse decision-making (Haushofer & Fehr, 2014). In its turn, risk aversion can trap the poor into persistent poverty because their risk aversion prevents them from investing in high-risk and high-return opportunities (Mosley & Verschoor, 2005). However, the empirical evidence of the correlation between risk aversion and economic welfare remains mixed. Limited to the studies that were conducted in low-income countries, the results on the correlation between risk aversion and economic

welfare are ranging from insignificant to significantly negative and positive (e.g., Binswanger, 1980; Liebenehm & Waibel, 2014; Tanaka, Camerer, & Nguyen, 2010; Vieider, Truong, Martinsson & Nam, 2013; Yesuf & Bluffstone, 2009). Further empirical evidence of the relationship between risk attitudes and economic welfare remains highly demanded. Similarly, what are the driving factors of this relationship and how to address them need further investigation.

Firstly, we need to consider the consistency of the measures of risk attitudes that were used in previous studies. In fact, many studies to date applied experiments that are context-dependent and sensitive to the cognitive skills of the subjects and to the elicitation methods. Consequently, some of those studies are subject to a sceptical discussion on the consistency and reliability of their measures of risk attitudes (e.g., Cook, 2015; Chuang & Schechter, 2015; Filippin & Crosetto, 2016). Instead, this study employs a survey question to capture the general willingness to take risks that was validated by the risk experiments in different populations (Dohmen et al., 2011; Hardeweg, Menkhoff & Waibel, 2013). Vieider et al. (2015) compared students' responses to incentivized lottery choices and survey measures across 30 countries and found significant correlations within most countries and between countries. They suggest using survey measures for cultural comparisons on risk attitudes. Therefore, this study tests this survey-based measure to capture the general individual risk attitudes among an ethnically diverse population of rural Vietnam.

Recently, Vieider et al. (2014a) was the first to examine the causal relationship between risk attitudes and economic welfare. However, by using different proxies of income such as land size and altitude, they could only reduce partly the endogeneity problem caused by measurement error. Hence, they tried to avoid a strongly interpretation of the causal effect. In fact, another cause of endogeneity that was suggested by Cardenas and Carpenter (2013) and Tanaka et al. (2010) has not considered so far. According to those researchers, the possible presence of reverse causality could explain why no significant correlation of the relationship between risk attitudes and income was found their studies. Therefore, this suggestion renders this study critically important to explore the mutual connection between risk attitudes and economic welfare.

Thirdly, the current study extends this body of literature by testing the assumption of a complex relationship in presence of cultural diversity. That is motivated by a suggestion from Bouchouicha and Vieider (2017) who indicated a "risk-income paradox" in the relationship between income and risk tolerance within and across countries. In particular, they found a negative when comparing between countries but a positive correlation when comparing

within countries. A similar "paradox" in the relationship between risk-taking and economic welfare can be tested across ethnic groups, provided that risk-taking is driven by cultural factors.

This study investigates the relationship between risk preferences and economic wellbeing in presence of ethnic diversity. It aims to emphasize the importance of ethnicity to drive the variations of risk attitudes and economic wellbeing. Furthermore, it demonstrates how this ethnic diversity shapes the patterns of the relationship between risk attitudes and economic welfare. It expects to contribute to the emerging literature on the linkage among culture, risk attitude and economic development. Furthermore, this study introduces new approaches to examine the association between economic welfare and risk attitudes. As a result, it explains to some extent the mixed results of this relationship in empirical studies across cultures or countries. In addition, this study expects to shed light on the persistent poverty and economic gap among ethnically diverse populations.

A multiethnic sample of some 580 individuals in a three-wave balanced panel collected from rural areas of Thua Thien Hue and Dak Lak provinces of Vietnam. The sample includes 13 ethnic minority groups that are proportional to their populations as well as well-presenting the ethnic minorities of Vietnam. Regarding ethnic diversity, Vietnam has 53 ethnic minority groups that contribute only 14 percent to the population, but account for almost half of the national poverty incidence (Kozel, 2014, p. 98). Studies documented the chronic poverty among the ethnic minorities and an increasing economic gap between the ethnic majority (Kinh) and the ethnic minorities despite the remarkable success in economic growth of the country (e.g., Fritzen, 2002; Kang & Imai, 2012). Different reasons were attributed to this gap such as the difference in endowments and the difference in returns of endowments, i.e. the structural effects (e.g., Imai, Gaiha, & Kang, 2011a; Van De Walle & Gunewardena, 2001). However, the absence of the relevance of cultural aspects in previous studies could be an important factor to understand why the efforts towards poverty alleviation are likely less effective among the ethnic minorities (World Bank, 2009, p.24). Indeed, the involvement of ethnic or cultural difference in attitudes and behaviors, including those towards risks is empirically evidenced (Vieider et al., 2014b). Therefore, the linkage between culture and economics that was indicated in literature (Throsby, 2001) deserves further investigation, in particular, for the case of the ethnically diverse population of rural Vietnam.

To meet the objectives, first, the survey-based measure of risk attitude is validated by testing its correlations with individual characteristics and household characteristics and its predictive power towards the risky behaviors in a risk experiment. Second, the single-equation

estimation using a fixed effects method and a correlated random effects method is applied to investigate the determinants of economic welfare. The patterns of the relationship between risk attitudes and economic welfare is particularly examined. In addition, the system-equation estimation using Three-Stage Least Squares method is employed to test a possible simultaneous dependency between risk attitudes and the economic welfare. Ethnic disaggregating analysis emphasizes the role of cultural factors in shaping risk attitudes and subsequently in driving the association between the individual risk attitudes and economic welfare.

The overall results indicate that ethnicity shapes risk attitudes and economic welfare, consequently influences their interdependency. Furthermore, the results provide insights into the mixed empirical results concerning this relationship across populations or cultures. First, this study indicates a non-linear relationship between risk attitudes and economic welfare when mixing ethnic groups that are culturally and socioeconomically diverse: that relationship is negative among the risk-averse and positive among the more risk-taking. Second, this study provides evidence of a mutual relationship between risk attitudes and economic welfare among the socially and culturally homogenous ethnic majority group.

The remainder of this essay is organized as follows. The conceptual framework and empirical evidence of the relationship between risk attitude, economic welfare and ethnicity are introduced in section 2. Section 3 presents the sample background and data descriptive statistics. Section 4 states the empirical strategies applied in this study. Finally, section 5 presents the empirical results and section 6 reports a summary and conclusions.

3.2 Relationship between risk attitudes, ethnicity and economic development

This section introduces a conceptual framework and literature review of the linkage among risk attitudes, ethnicity and economic development with a focus on the developing countries. It indicates a connection between the theoretical framework and the existing empirical evidence of the relationship between risk attitudes and economic welfare and the need of further evidence. This study aims to bridge the linkage between risk attitudes and economic welfare to the linkage between ethnicity and economic development.

3. 2.1 Risk attitude and economic development

Risk attitude is one of the elements in the endogenous growth model (e.g., Klasing, 2014; Doepke & Zilibotti, 2014). On the development pathway, risk-taking can be both a cause of and a consequence from the economic growth process. In other words, risk attitude is

endogenous in the economic growth model at the same it can also have mutual interaction with economic development.

On the one hand, risk-taking can enhance the process of economic development. At the national level, significant differences in risk attitudes are found within and between countries (Guiso, L., & Paiella, 2008; Harrison, Lau, & Rutström, 2007). Similarly, Bouchouicha & Vieider (2017) suggest that the relationship between risk attitudes and economic welfare is positive or negative that depends on the economic growth levels. At the household level, risk-taking is found to be passed from parents to their children (Dohmen et al., 2012), at the same time, risk-taking drives entrepreneurship that leads to economic growth (Klasing, 2014). At the individual level, risk-taking influences the individual occupational choices (Bonin, Dohmen, Falk, Huffman, & Sunde, 2007). Accordingly, more risk-taking increases the probability that a person chooses to be self-employed (Caliendo, Fossen, & Kritikos, 2009; Cramer, Hartog, Jonker, & Van Praag, 2002). Similarly, risk-taking encourages the adoption to technologies among farmers (Liu & Huang, 2013).

On the other hand, risk aversion could be the result of the economically disadvantaged background. To be specific for the poor, there is an association between risk aversion and poverty in the way that risk aversion hinders the poverty reduction (e.g., Klasen et al., 2015; Günther & Maier, 2014). Indeed, the poor people tend to involve in risk-averse income smoothing strategies (Rosenzweig & Binswanger, 1992), similarly, they are prone to be risk-averse in using labor (Jayachandran, 2006) and more reluctant to adopt new agricultural technologies (Liu, 2013). Therefore, risk aversion is a key element to understanding the persistent poverty (Mosley & Verschoor, 2005). Similarly, it could be possible that risk aversion is relevant to the inequality that exists within a population in presence of a significant correlation between risk attitudes and economic outcomes.

Empirical studies that investigate the correlation between risk attitudes and economic development indicate mixed results (e.g., Binswanger, 1980; Liebenehm & Waibel, 2014; Tanaka et al., 2010; Vieider, Truong, Martinsson, & Nam, 2013; Yesuf & Bluffstone, 2009). Some studies document no significant relationship between risk preferences and economic welfare, for instance, in the samples of rural populations in India and in Vietnam (Binswanger, 1980; Tanaka et al., 2010). To better understand these mixed results, the following concerns need deeper consideration.

First, measurement of risk attitudes has been prone to controversy in the literature. Various methods of risk attitude elicitation have been used along the line might be a reason for the

mixed results across studies. Many studies applied various incentivized risk experiments to elicit risk preferences. However, these experiments are context-specific and sensitive to the subjects' cognitive ability. Therefore, many of them are subject to skeptical discussions about their reliability to measure risk attitudes (e.g., Cook, 2015; Chuang & Schechter, 2015). Similarly, experiments reveal some weaknesses in capturing risk attitudes, such as that they turn less consistent under tests when compared with a survey question (Lönnqvist, Verkasalo, Walkowitz, & Wichardt, 2015). In contrast, the intrinsic individual risk attitudes measured by the survey question is correlated with other personality's traits (Lönnqvist et al., 2015). This question was validated by risk experiments (Dohmen et al., 2011; Hardeweg et al., 2013) to powerfully elicit the general risk attitudes in different populations. In particular, the simplicity of a survey question is preferable to an experimental method in the context of developing countries (Chuang & Schechter, 2015). It could be interesting to test the capacity of this survey question among different cultures because cultural factors can shape risk attitudes (Vieider et al., 2014b).

Second, conceptually, risk attitudes and economic welfare are mutually related. This interaction causes reverse effect that challenges the unidirectional empirical method that is used to understand the relationship between risk attitudes and economic wellbeing. To my best knowledge, empirical evidence of this reverse causation is missing because most of previous studies limited their analysis to the correlation rather than a causal relationship. Not to mention that the current methodological background has its limitation to address the mutual causality. In some cases, that was due to the data limitations as well as the purposes of the estimation analyses in those studies. Some studies suggested that this uncontrolled reverse causality might explain why they did not find a significant correlation between the economic wellbeing (i.e. income) and risk preferences such as Tanaka et al. (2010) and Cardenas and Carpenter (2013). Because this suggestion has been not considered, it renders this study critically important to explore the first evidence of a mutual relationship between risk attitudes and economic welfare.

3.2.2 Ethnicity and economic development

Ethnic diversity can lead to economic growth but only under the condition of the well-developed markets to encourage trade across boundaries between ethnic groups (Montalvo & Reynal-Querol, 2016). However, the ethnic diversity can hinder the economic growth once this cooperation among different ethnicities breaks down (Churchill, 2017b). For instance, a significant association between ethnic fractionalization and the decreasing financial performance of microfinance institutions was documented (Churchill, 2017a). Consequently,

ethnic diversity has both negative and positive effects on economic development. In which, the negative effect is strongly related with the situation of undeveloped economies and imperfect markets. These negative effects can be either indirectly or directly rooted from the ethnic diversity.

Firstly, ethnic diversity could have negative impact on social network, trust, and social capital, consequently on economic development (e.g., Alesina & Zhuravskaya, 2011; Dincer, 2011). Indeed, higher ethnic diversity is found to be associated with lower trust (Beugelsdijk & Klasing, 2016). The difference in cultures or behaviors could obstruct the cooperation across ethnic groups (e.g., Miguel & Gugerty, 2005; Alesina & Zhuravskaya, 2011; Dincer, 2011). Consequently, mistrust can lead to stereotypes that prevent certain groups from accessing to business opportunities and financial institutions (Fafchamps, 1996). Moreover, ethnic diversity is associated with the poor institutional system and public goods that eventually cause poverty (Miguel, 2006) especially among the disadvantaged groups, i.e. the ethnic minorities. Hence, ethnic diversity is detrimental to the economic circumstances of these groups, particularly, without the presence of well-functioning markets. Similarly, the diversity could be relevant to the inequality across ethnic groups.

Secondly, ethnic diversity could have a directly negative effect on economic development. For example, Churchill, Okai, and Posso (2016) stated that there is an association between the ethnic diversity and persistent poverty due to a hierarchical structure in which the superior role belongs to the ethnic majority. Hence, there exists persistent poverty among ethnic minorities in some countries because of the disadvantages that have lasted for a long time such as having fewer opportunities and facing discrimination (Epprecht, Müller & Minot, 2011; Gustafsson & Sai, 2009). Stereotypes and social exclusion due to ethnic identity can be one of the causes of poverty and inequality (e.g., Maass, Roasbianca & Kiesner, 2005; Hoff & Pandey, 2006; Porter & Craig, 2004).

Regarding the ethnic diversity among the rural population of Vietnam, many studies documented the persistent ethnic economic gap (e.g., Imai et al., 2011a; Kang & Imai, 2012; Van De Walle & Gunewardena, 2001). Some of these studies attribute this gap to the difference in endowment or to the returns to the endowment that differ across groups. However, literature lacks of evidence of the role that the relationship between risk attitudes and economic welfare plays in the ethnic gap in Vietnam. The positive association between risk-taking and economic development that is witnessed across countries (e.g., Gloede et al., 2015; Hopland, Matsen, & Strøm, 2016; Vieider et al., 2013) supports the expectation for the

linkage between risk attitudes to economic welfare in the ethnically diverse population of Vietnam.

3.2.3 Cultural factors and risk attitudes

Cultural diversity and ethnic diversity are "two sides of the same coin" and the empirical evidence shows that ethnicity predicts cultural factors (Desmet, Ortuño-Ortín, & Wacziarg, 2017). Accordingly, ethnicity is expected to be related to human attitudes including that towards risks. For instance, culture influences risk-taking in health issues among adolescents (Christopherson & Jordan-Marsh, 2004). Similarly, culture impacts risk-taking of the corporate managers (Li, Griffin, Yue, & Zhao, 2013). Furthermore, culture or considerably similar to ethnicity is represented by languages, social networks, and cultural heritage that result from social norms and social identity of the people within an ethnic group. Among them, languages influence cognitive skills, the spread of technologies, and education, resulting in the social recognition and reputation. Consequently, they influence preferences and behaviors, including that towards risks (i.e. in economic decision-making) (Hoff & Stiglitz, 2016). Nevertheless, the evidence of the relationship between ethnicity and risk attitudes in the existing literature is limited.

3.3 Sample background and descriptive statistics

The data used in this study are apart from the long-term project: "Thailand Vietnam Socio Economic Panel", funded by the German Research Foundation (see www.tvsep.de). The project collected data from approximately 4000 households in six provinces of Thailand and Vietnam starting in 2007. This study uses data from three survey waves conducted in 2008, 2010, and 2013 in two provinces of Central Vietnam, namely Thua Thien Hue (Hue) and Dak Lak. The data are restricted to those respondents who remain household decision makers resulting in a sample of 588 individuals in a three-wave balanced panel.

Vietnam is a multiethnic country with 53 ethnic minority groups making up 15 percent of the population and one ethnic majority, namely Kinh. A strong diversity among those ethnic minority groups is recognized in terms of languages, customs, beliefs and other social aspects (Hoàng Anh Tuấn, 2013, March 11). The socioeconomic gaps between the majority (i.e. Kinh) and ethnic minorities are profound among Vietnamese populations (e.g., World Bank, 2009; Baulch, 2011; Kozel, 2014; Cuong, Tung & Westbrook, 2015). Some studies found that the difference in returns to endowments or the structural effects are more important to explain the ethnic gaps in comparison to the difference in endowment (e.g., Imai, Gaiha & Kang,

2011a; Van De Walle & Gunewardena, 2001). Similarly, ethnic minorities in Vietnam are facing both "hidden and overt discrimination" as documented by some studies (e.g., Baulch, 2011, p.15). For instance, hidden discrimination in terms of stereotypes, such as "ethnic minorities do not know how to make a living, how to use credit effectively, how to use technology or raise livestock, they do not consume and have low intellectual levels" (World Bank, 2009).

Concerning ethnic diversity of the research sample, the minorities account for approximately 30 percent of the population, this proportion is slightly smaller in Hue. The largest minority group in Dak Lak province is Ede with 13 percent, while the Paco constitute the largest minority group in Hue province with 6 percent. Each of the other twenty minority groups in both provinces accounts for about 3 percent or less. Ethnic minorities in these provinces are representatives of their populations as well as the ethnic minorities of Vietnam.

The left panel of Table 3.1 demonstrates the differences and statistic tests between the ethnic majority and the ethnic minorities. The results confirm the ethnic disparities in Vietnam (e.g., Baulch, 2011; Kozel, 2014; Cuong, Tung, & Westbrook, 2015; World Bank, 2009). The ethnic majority have 58 percent higher in consumption expenditure and about 80 percent higher in income. Also, only 16 percent of the majority suffers from poverty while it is about 54 percent of the minorities (see notes of Table 3.1 for definition of poverty).

Furthermore, the minorities are left behind regarding many different aspects of living standards. The ethnic minorities have less official education that is captured by the number of schooling years. They have fewer opportunities to migrate out of their province to probably search for jobs or study. They are more dependent on agriculture and therefore experience more agricultural shocks[2]. Similarly, they are less likely involved in nonfarm self-employed activities to diversify their income sources. They tend to live in larger size families with more dependent members. The ethnic minorities are living in smaller and less valued houses with fewer rooms and they change their shelters more often. They are more often located in the mountainous areas with lower quality of water and transportation as well as farther away from the district center.

All aforementioned gaps between minority and Kinh households persist over the years, despite of the improvements in living standards within each group. That could be a reason for

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[2] The variables shocks are calculated by counting numbers of shocks experienced by the household over the last one year. These shocks are categorized according to their impacts into socio-demographic shocks, agricultural shocks and economic shocks.

that the ethnic minorities self-report to be less optimistic about their future well-being and less willing to take risks than the ethnic majority.

Table 3.1: Descriptive statistics

	(1)			(2)		
	Minorities (522)	Majority (1,242)		Ede (n = 222)	Other minorities (n = 300)	
Variable	Mean	Mean	Statistic test#	Mean	Mean	Statistic test#
Economic status						
Consumption [a] (PPP USD)	3.73	5.90	-15.90***	3.96	3.56	2.01**
Poverty (%)[h]	54	16	263.19***	52	56	0.77
Wealth[c] (PPP USD)	445.23	936.66	-12.06***	497.77	406.35	1.13
Income[b] (PPP USD)	3.14	5.64	-11.40***	3.12	3.15	0.76
Individual characteristics						
WTR	3.70	4.65	48.66***	2.95	4.25	40.85***
Age	42.93	50.14	-10.70***	43.36	42.60	0.96
Female (%)	33	43	16.79***	26	38	8.80***
Married (%)	87	83	4.84**	88	86	0.25
Self-employed (%)	5	23	81.33***	4	6	0.99
No religion (%)	74	80	6.63**	49	93	133.51***
Health impairment (%)	25	22	1.02	28	22	3.11*
Optimism[f]	0.37	0.46	9.24*	0.32	0.42	3.23
Membership[d] (%)	61	68	8.31***	42	75	58.54***
Education (years)	5.00	6.16	-5.85***	4.46	5.41	-2.77***
Household characteristics						
Household size[e]	5.03	4.04	8.97***	0.10	0.12	4.04***
Household dependency ratio	0.38	0.38	2.02**	5.48	4.70	0.04
Non-farm land (ha)	0.89	0.60	8.71***	0.37	0.38	-1.25
Crop land (ha)	0.63	0.26	8.75***	0.72	1.01	-2.88***
Member average age (years)	27.66	35.85	-11.72***	26.39	28.61	-2.33**
Member average education	4.78	6.86	-12.69***	4.16	5.24	-4.23***
Migrating members[e]	0.08	0.35	-7.52***	0.07	0.09	-1.25
Literate members[e]	3.70	4.07	-4.62***	3.83	3.61	0.82
Self-employed members[e]	0.11	0.55	-12.61***	0.06	0.14	-2.59***
Experience with shocks						
Economic shocks[e]	0.27	0.24	0.76	0.26	0.28	-1.05
Agricultural shocks[e]	1.08	0.63	9.28***	0.87	1.24	-3.92***
Socio-demographic shocks[e]	0.49	0.44	1.39	0.58	0.42	2.36**
Infrastructure (village level characteristics)						
Distance to district town (km)	15.54	12.80	1.79*	16.24	15.02	1.74*
Water quality (scale)	3.79	3.10	165.61***	3.93	3.69	93.51***
Stability (years)	8.49	12.15	-7.59***	8.67	8.36	1.90*
Road quality (scale)	2.57	2.99	68.13***	2.00	3.00	167.96***

Notes: [a] Daily consumption per adult equivalent (AE): Organization for Economic Cooperation and Development adult equivalents AE = 1 + 0.7*(adults-1) + 0.5*children. [b] Daily income per capita. [c] Total asset value (wealth) per capita. [d] Be member of a social or political organization. [e] Counted numbers. [f] Scale from -2 to 2. [g] WTR: willingness to take risks. [h] A new poverty line was constructed using a cost-of-basic-needs approach and calculated based on the updated poverty line proposed by the General Statistical Office – World Bank (GSO-WB) in 2010 (expenditure per person per month of 653,000 VND, equivalently 22,600VND/day, PPP equals to 3.09 USD), which is substantially higher than the original GSO-WB poverty line. The increase reflects improvements in the quality of the food reference basket, the Food Energy Intake method (fewer calories from rice, more consumption of proteins, vegetables, and fats) and a higher allocation for basic nonfood spending, including housing and durables. # Prtest (test for the same proportion between two groups) is used for dummy variables Chi-square test for categorical variables and nonparametric two sample test (Mann-Whitney test) for other variables. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.

Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations.

The Vietnamese government has taken a lot of effort to support ethnic minorities. Indeed, there is a considerable reduction in poverty headcount ratio of 23 percent from 2008 to 2013 among the ethnic minorities. This could benefit from the government's supporting project (Cuong, et al., 2015). However, the persistent ethnic gap, despite of the efforts to support ethnic minorities, suggests reconsidering the interventions that targeted the ethnic minorities but ignored their cultural differences. Indeed, policy interventions have been designed according to the dominant group's standards rather than cultural-specific strategies (Baulch et al., 2007). Therefore, the ethnic minority groups who share similar socioeconomic and cultural backgrounds with the majority achieved better economic improvement, while other groups who remained strongly attached to their own values obtained less progress (Baulch et al., 2007).

Since socio-cultural factors influence human attitudes and behaviors (Hoff & Stiglitz, 2016), the difference in risk attitudes across ethnic groups is no surprise. More specifically, an average member of the ethnic majority reports almost 1 point higher on the 11-point Likert scale of the willingness to take risks in comparison with an average member of the ethnic minority. The process of adopting standards from the ethnic majority could be affected by the willingness rather than the capacity to do this. That leads to the linkage between the cultural factors and socioeconomic gaps between the ethnic majority and their ethnic minority counterparts. For instance, some studies found that socio-cultural factors influence behaviors towards risks in health among Vietnamese (Rheinländer, 2010). Consequently, the horizontal inequality has been recognized as a cause of unsuccessful programs in health care and education and biased treatments towards the ethnic minorities (e.g., Tran & Walter, 2010; Målqvist et al., 2013).

To explore further the ethnic heterogeneity in the sample background, this study compares Ede who is the largest ethnic minority group with about above 40 percent of the ethnic minority's population to the other ethnic minorities (Table 3.1, panel 2). Similar statistics tests are calculated for the gaps between Ede and the rest of the ethnic minorities including 12 different groups. Despite the similarity in most of the variables representing living conditions, significant differences are found in some social and cultural aspects between Ede and other ethnic minorities as follows. First, on average, Ede people show stronger risk aversion, about 1.3 points lower on the 11-point Likert scale, whereas, they are significantly indifferent in almost all economic indicators. This is a crucial point to support the first hypothesis that there might be a more complex than a linear relationship between risk attitudes and economic welfare if we pool all ethnic groups together. Second, Ede people report themselves to be

more religious at the same time less willing to take risks. That is in line with some studies which find that more religious people tend to be more risk-averse (e.g., Noussair et al., 2013; Nielsen et al., 2017). Third, Ede people are found to have slightly less official education and to be much less likely to be involved in social or political organizations in comparison to other ethnic minorities.

Choosing a good proxy for economic welfare is crucial to examine its relationship with risk attitude without bias. To illustrate, Vieider et al. (2013) found a strong correlation between risk tolerance and income but it has no significant correlation with wealth. Proxies might be different from each other due to their own characteristics (i.e. long-term or short-term) as well as due to the collection process. These differences might be involved in the mixed results in empirical studies to date. For instance, consumption expenditure seems to be more precise in developing countries because it could capture long-term economic welfare of households (Haughton & Khandker, 2009). In addition, consumption expenditure presents as a better measure in comparison to income because income could be underreported, such as households might not be willing to report true information of income if it is illegal (Parvathi & Nguyen, 2018).

The changes between 2008 and 2013 in household consumption expenditure within and between the ethnic majority and the minorities are reported in Figure 3.1. The gap between two groups is captured by the distance between two cumulative distribution functions: the continuous line represents the minorities and the dashed line represents the majority. The majority is economically better-off in all years. In addition, the gap in daily consumption per adult equivalent between Kinh and ethnic minorities increased on average from 2.13 to 2.26 USD (purchasing power parity) (Appendix A, Table A1). This increasing gap is in line with inefficient poverty reduction among the minority groups (e.g., Baulch, Pham, & Reilly, 2012; World Bank, 2009, p. 24).
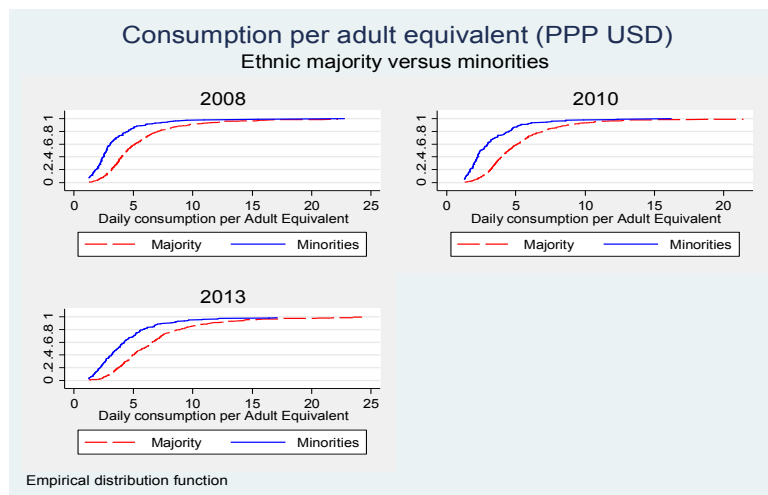
Figure 3.1: Economic gap between the ethnic majority and minorities

Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations

Risk attitude is measured by the self-assessed willingness to take risks (WTR), a survey-based question using an 11-point Likert scale. The survey question reads, "Are you generally a person who is fully prepared to take risks, or do you try to avoid taking risks? Please choose a number on a scale from zero (unwilling to take risks) to ten (fully prepared to take risks)". This simple survey question is sufficiently validated by risk experiments in different countries (e.g., Dohmen et al., 2011; Hardeweg, Menkhoff & Waibel, 2013) to reveal individual attitudes towards real-life risky decisions. Furthermore, this measure is less noisy than an incentivized measure under tests (e.g., Lönnqvist, Verkasalo, Walkowitz & Wichardt, 2015).

Similarly, the overlapping histograms of WTR of the Kinh majority and the ethnic minorities are presented in Figure 3.2. The changes in WTR between 2008 and 2013 and the gap between the majority and the ethnic minorities are presented. There is a relatively stronger willingness to take risks among the ethnic majority in comparison with the ethnic minorities. The gap is about 1 point on average over time on the 11-Likert scale and it is strongly statistically significant. This gap of roughly one point remains in spite of changes in risk-taking within each group over the years.
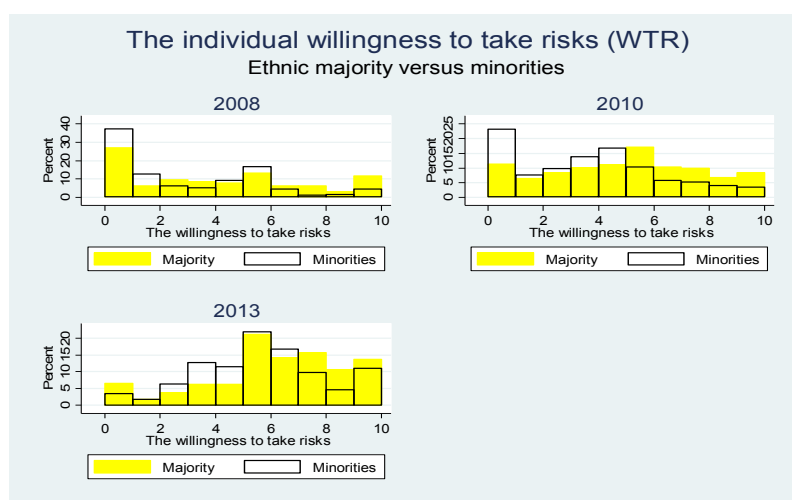
Figure 3.2: The general willingness to take risks (WTR)

Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak

In sum, Figure 3.1 and Figure 3.2 demonstrate the tendency for changes in household consumption expenditure and WTR, respectively, over the years with visible persistent differences between the ethnic majority and ethnic minorities. The overall descriptive results confirm an economic gap and the difference in risk attitudes between ethnic majority and minorities. The concurrent changes in risk attitudes and economic welfare over time allow us to expect some relationship between them. The following section introduces the strategy used to test our hypotheses.

3.4 Empirical strategy

The research objectives are approached by both single-equation and system-equation methods. In the first approach, the heterogeneities of the determinants of risk attitudes and economic welfare are explored with an emphasis on the role of ethnicity. In the second approach, the system-equation estimation is applied to test the second hypothesis of a mutual relationship between risk attitude and economic welfare. By disaggregating ethnicity, the ethnic dimension of the association between risk attitudes and economic welfare uncovered.

3.4.1 Estimation of risk attitudes

In this section, the reliability of the self-assessed measure of risk attitudes is tested for its association with individual and household characteristics. Even though consumption expenditure is used as proxy of household economic welfare (E) in the entire study, in this

analysis, we use the self-reported house's value as the proxy of economic status[3]. The analysis employs various regression methods including interval regression, ordered probit, and OLS regression to check the robustness of the results.

Risk attitude is a personal trait, empirically found to be in association with personality factors (Lönnqvist et al., 2015). This trait can be shaped by socioeconomic variables (Guiso & Paiella, 2008). The application of this question to the general willingness to take risks is found to be significantly correlated with its applications on different risk domains such as stock holdings, job choices and smoking (Dohmen et al., 2011). These authors also pointed out that the general application of this question has the best ability to predict risky behaviors. In addition, this measure is significantly correlated with an incentivized measure of risk attitude when comparing between countries (Vieider et al., 2014b). That implies that this survey-based measure can be applied and compared across cultures.

The multivariate correlates of the willingness to take risks (WTR) of an individual i at time t are estimated in the following specification:

$$WTR_{it} = \alpha_0 + \alpha_1 X_{1it} + \alpha_2 Z_{1it} + \alpha_3 G_j + \alpha_4 (\boldsymbol{E_{it}}) + v_{it}, \tag{1}$$

where: $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$, and α_5: parameters or vectors of parameters are to be estimated, v_{it} is error term and $t = 1,2,3$.

A set of individual characteristics, X_{1i}, includes age, gender, marital status, ethnic identity, employment status, education and subjective attitudes, namely health impairment and attitude toward future wellbeing; and Z_{1i} is a set of household characteristics believed to be associated with individual risk attitudes, such as household size, dependency ratio and household's experience with shocks. In addition, the geographic characteristics G_j are controlled at the village level (j).

To be learnt from previous studies (e.g., Dohmen et al., 2011; Gloede, Menkhoff & Waibel, 2015; Liebenehm & Waibel, 2014; Miyata, 2003), some significant correlations between risk attitudes and the socio-demographic determinants, such as age, gender, education, and marital status are expected. Furthermore, subjective opinions about health status and future wellbeing are expected to be significantly correlated with risk attitudes (Dohmen et al., 2011; Hardeweg

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[3] This variable is found to strongly correlate with other indicators of economic welfare including consumption, income and assets. In comparison with the results of using different proxies, house value provides the most consistent outcomes in this analysis. In addition, house is treated as a stable and long-term asset of a household.

et al., 2013). Similarly, the variable of religion is of interest of this study because previous studies suggested significant relevance of religiosity in risk-taking behaviors. For instance, religious people are more likely risk-averse that is found among a Dutch population by Noussair et al. (2013) and among Germans by Nielsen et al. (2017). Shocks and other negative experiences interfere with risk attitudes, thereby causing changes in risk attitudes over time (e.g., Gloede et al., 2015; Liebenehm, 2018; Malmendier & Nagel, 2011). In addition, geographic effects are proxied by the household's distance to the district town and province dummy variable because these variables can represent accessibility to information that encourages capacity to take risks. In low-income communities, risk sharing among members within a group helps limit consumption risk. As a result, membership in socio-political organizations, which provides channels for risk-sharing activities, can be related to household consumption expenditure and risk attitudes (Grimard, 1997).

3.4.2 Estimation of economic welfare

This analysis examines the determinants of household welfare. A large number of independent variables that were found to explain economic welfare are adopted from previous studies (e.g., Akerele & Adewuyi, 2011; Litchfield & Mcgregor, 2008; Mukherjee & Benson, 2003). In particular, individual and household characteristics such as age and gender of the household decision maker, endowment in education, land size, social capital, and experience with shocks determine household's economic welfare (e.g., Epprecht, Müller & Minot, 2011; Günther & Harttgen, 2009; Klasen, Lechtenfeld & Povel, 2015). In addition, regional effects (coastal, mountainous, province), location effects (i.e. distance to the district town, water source, and length of time living in current house) have significant effects on the economic welfare of the Vietnamese population (Imai, Gaiha & Kang, 2011b).

For estimation, daily consumption per adult equivalent is converted to a logarithm. Then, economic welfare (W) of household i is regressed on the set of individual characteristics of household decision maker (X_{2i}), set of household characteristics (Z_{2i}), where V_j denotes geographic characteristics at the village level (j). Among them, the individual willingness to take risks (WTR) of the household decision-maker is expected to play a decisive role. The specification is illustrated below.

$$\log(W_{it}) = \beta_0 + \beta_1 X_{2it} + \beta_2 Z_{2it} + \beta_3 V_j + \beta_4 \boldsymbol{WTR_{it}} + \mu_{it}, \qquad (2)$$

where: $\beta_0, \beta_1, \beta_2, \beta_3$ and β_4 parameters or vectors of parameters to be estimated, μ_{it} is error term and $t = 1,2,3$.

Ethnic diversity is found to have effects on a community's economic development (Maass, Roasbianca & Kiesner, 2005). Social exclusion due to ethnic identity among other factors can cause poverty and inequality (e.g., Hoff & Pandey, 2006; Porter & Craig, 2004). To expect a link between ethnicity and poverty and inequality, the variable of ethnicity is added to this analysis to examine the persistent ethnic economic gap in Vietnam from the risk-welfare channel (e.g., Imai et al., 2011a; Kang & Imai, 2012; Van De Walle & Gunewardena, 2001). By introducing the variable of risk attitudes, this analysis revisits the strand of literature that suggests a positive association between risk-taking and economic development globally (e.g., Gloede et al., 2015; Hopland, Matsen & Strøm, 2016; Vieider et al., 2013). To some degree, the geographic and institutional effects are eliminated focus on other factors that explain ethnic gap in economic wellbeing within a region.

Random effects, fixed effects and OLS regressions are applied to panel data. The Hausman test's (Greene, 2012, p.421) results decide which model fits the best for the data. Nevertheless, fixed effects model might theoretically not be the best to approach the objective in observing the heterogeneity of economic welfare. Furthermore, to test the hypothesis of a non-linear relationship between risk attitude and economic welfare, a residual analysis is conducted to observe the shape of the relationship between WTR and the unexplained variation of economic welfare. In addition, to test the assumption that there is endogeneity in the relationship between risk attitudes and economic welfare, the Durbin-Wu-Hausman test (Davidson & MacKinnon, 1993, p.235–236) is applied.

3.4.3 Simultaneous estimation of risk attitude and economic welfare

The assumption on a conceptualized mutual relationship between risk attitudes and economic welfare needs empirical evidence. This assumption leads them to be endogenous, interdependent, and jointly determined. Hence, the assumption on exogeneity in the single-equation estimations is violated, thereby causing simultaneity bias. At the same time, the reciprocal interaction could also lead to the related unexplained variations of risk attitudes and economic welfare. These hypotheses are tested by applying a system of equations to estimate risk attitudes and economic welfare simultaneously using Three-Stage Least Squares (3SLS) estimation (Zellner & Theil, 1962). The equation system not only takes notice of the joint-endogeneity of the dependent variables but also accounts for the mutual interaction between two equations. The simultaneous estimation is expected to be an unbiased and efficient estimation and to have a twofold advantage in comparison with single-estimation method. First, the estimation allows for the endogeneity problem of two explained variables by assuming that the exogenous variables of the system are able to instrument the endogenous

variables of the system. As a result, the system obtains the requirement of over identification. Second, the estimation can also consider the existing mutual interaction between two variables by allowing correlated error terms.

This analysis addresses the mutual relationship between risk attitudes and economic welfare by a system-equation estimation method. By emphasizing the driving force of cultural factors proxied by ethnic difference, the study aims to investigate the 'risk-income paradox' suggested by Bouchouicha & Vieider (2017). While those researchers analyzed the relationship between risk aversion and economic development within and between countries (i.e. cultures), a national-level analysis is introduced in this study. Moreover, the attention is paid to the heterogeneity of determination of both risk attitudes and economic welfare. Significance of several time-invariant factors such as ethnicity and geographic features are expected.

Even though, this study does not aim to deal with all causes of endogeneity in the relationship between risk attitudes and economic welfare, it addresses the possibility of simultaneity bias that leads to the problem of endogeneity bias. Even if a fixed effects model is applied, the regressors in the equation (2) can be correlated with a time constant error component, but they must be exogenous to the past, the present and future time variant errors. In such a way, the system-equation estimation is suggested to reduce this disadvantage of a fixed effects regression to address the endogeneity problem caused by simultaneity bias (i.e. the possibility of a correlation between the regressor and the time-variant error). In addition, the mutual interaction between error terms of two equations allows for the possibility of a correlation between the regressor and the past and future time-variant error (i.e. the dynamic dimension of the relationship between endogenous variable and the regressor).

The simultaneous system is presented in its structural form as follows:

$$\begin{cases} log(W_{it}) = \lambda_0 + \lambda_1 X_{2it} + \lambda_2 Z_{2it} + \lambda_3 V_j + \lambda_4 \boldsymbol{WTR_{it}} + u_{1it} \\ WTR_{it} = \gamma_0 + \gamma_1 X_{1it} + \gamma_2 Z_{1it} + \gamma_3 G_j + \gamma_4 \boldsymbol{log}\,(\boldsymbol{W_{it}}) + u_{2it} \end{cases} \tag{3}$$

Variables included in the systems have similar definitions as they have in equation (1) and equation (2). Explanatory variables such as sets of X_1, X_2, Z_1, Z_2, V and G assumed to be exogenous (determined outside of the model). The system takes notes of the simultaneity of the variables of willingness to take risks (WTR) and economic welfare (W). They are interdependent and determined jointly. Additionally, the system takes into account the mutual interaction between the equations. Therefore, for a given observation i, the errors of two

equations are correlated: $E(u_1 u_2 | X) = \delta_{12}, (\delta_{12} \neq 0)$, but u_1 and u_2 are assumed to be homoscedastic and identically and independently distributed: $E(u_1) = 0$ and $E(u_2) = 0$.

The estimation is executed in two steps: in the first step, the predicted outcomes of each dependent and (endogenous) variable are calculated in a linear regression on all exogenous variables of the system. The calculated values are required to instrument the endogenous variables of the system. In the second step, the predicted outcomes of endogenous variables are used instead of actual outcomes in the full specification. The error terms of two equations are allowed to be correlated because WTR and economic welfare might have reciprocal interaction within the system.

Three assumptions need to be fulfilled for a consistent and efficient estimation, when compared with the single-equation estimation method. First, two equations are assumed to be jointly dependent that proves the suitability of simultaneous estimation over the single-equation estimations is needed. Second, over-identification is required to assure the validity of the instruments (i.e. the exogenous variables) in the system to deal with the endogeneity bias. Third, the error terms, u_1 and u_2, are homoscedastic and independently and identically distributed but correlated with each other in the system. To test the above assumptions, the Breusch-Pagan LM Diagonal Covariance test to see whether the simultaneous equation presents more appropriate than the single equation estimation for undertaking the task. Second, the Hansen-Sargan test is to check if the equation system is over-identified to accept the null hypothesis that the exogenous variables of the system are qualified to instrument the endogeneity. The System Heteroscedasticity test is applied to test the presence of homoscedastic variance of each single equation and heteroscedastic covariance of the whole system.

3.5 Model results

We estimate risk attitudes using equation (1) and economic welfare using equation (2); results are reported in this section. In section 5.1, the survey-based measure of risk attitudes is validated by its correlates with individual and household background variables as well as its predictive power towards risky behaviors in a risk experiment. The economic welfare is regressed in single-equation estimation with awareness of the endogeneity problem in section 5.2. Section 5.3 addresses the reciprocal relationship between risk attitude and economic welfare by applying the method of system equation estimation.

3.5.1 Multivariate analysis of the survey-based risk attitudes

This section verifies our survey question to measure the general willingness to take risks by analyzing its correlation with individual and household background variables. The results in Table 3.2 confirm most of our expectations on the correlates of the individual willingness to take risks and agree with the results of previous studies. The results of different estimation methods are reported to evaluate the robustness. In particular, interval regression is reported in columns (1), (2) and (3) with different specifications. Results of the ordered probit regression are reported in column (4), and OLS regression presents in column (5); both regressions are applied with the similar specification as in column (3).

The results are highly qualitatively consistent across estimation methods. The correlates of risk attitudes confirm findings from previous studies. In particular, positive correlations are found from the variables of civil status (i.e. married), economic status, self-employment and education. These findings are in line with that of previous studies (e.g., Dohmen et al., 2011; Donkers, Melenberg, & Van Soest, 2001; Hardeweg et al., 2013; Miyata, 2003). In contrast, we find that living in a household with a large number of dependent members discourages risk-taking that is similar to findings of previous studies from different populations (e.g., Dohmen et al., 2011; Liebenehm & Waibel, 2014). Similarly, experience with socio-demographic shocks reduces the individual willingness to take risks that is similar to the finding from Gloede et al. (2015). In addition, we find evidence of a strong and positive correlation between the optimism towards future wellbeing and risk-taking as found in other studies (e.g., Dohmen at el., 2011; Hardeweg et al., 2013).

Our analysis indicates the positive correlations of ethnicity and religion to highlight the influence of cultural factors on risk attitudes. However, the significance is declining when controlling more background variables. We particularly pay attention to the strongly and significantly positive correlation of education on risk attitudes. The correlation that remains consistently significant regardless of different specifications emphasizes the importance of education in shaping risk attitudes among the low-income and less-educated communities.

Table 3.2: Multivariate correlates of the general willingness to take risks (WTR)

Variables/Model variant:	[1]	[2]	[3]	[4]	[5]
Female	-0.016	0.015	-0.042	-0.018	-0.051
	[0.197]	[0.195]	[0.198]	[0.064]	[0.165]
Age	-0.007	-0.009	-0.001	-0.000	-0.001
	[0.007]	[0.007]	[0.008]	[0.003]	[0.006]
Married	0.675**	0.558**	0.617**	0.201**	0.513**
	[0.266]	[0.267]	[0.275]	[0.089]	[0.227]
Ethnic identity	0.696***	0.566***	0.381*	0.135**	0.313*
	[0.190]	[0.192]	[0.200]	[0.065]	[0.166]
No religion	0.586***	0.489**	0.374*	0.118*	0.253
	[0.198]	[0.196]	[0.198]	[0.064]	[0.164]
Education	0.132***	0.125***	0.099***	0.033***	0.081***
	[0.022]	[0.022]	[0.023]	[0.007]	[0.019]
House value♦		1.963***	1.312**	0.427**	1.276***
		[0.563]	[0.580]	[0.188]	[0.471]
Household size			-0.069	-0.022	-0.067*
			[0.049]	[0.016]	[0.040]
Dependency ratio			-0.473*	-0.159*	-0.425*
			[0.268]	[0.087]	[0.221]
Self-employed			0.492**	0.161**	0.404**
			[0.216]	[0.070]	[0.178]
Membership			0.282	0.091	0.205
			[0.175]	[0.057]	[0.143]
Impairment			-0.410**	-0.139**	-0.340**
			[0.205]	[0.066]	[0.167]
Optimism			0.659***	0.218***	0.597***
			[0.127]	[0.041]	[0.103]
Constant	-0.407	-4.259***	-2.874**		-1.329
	[0.537]	[1.212]	[1.250]		[1.022]
Pseudo R^2/R^2	0.044	0.048	0.060	0.061	0.248
Observations	1762	1746	1696	1696	1696

Notes: Random effected regressions. The dependent variable is the self-reported willingness to take risks. ♦ self-reported market price of the house, in natural logarithm. 1-3: Interval regression estimates, 4: Ordered Probit estimates and 5: Pooled OLS estimates Standard errors in brackets, Control for time and province effects. Sample size changes across regressions due to missing values of some observations in some variables. Significance levels: *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations

3.5.2 Determinants of economic welfare

The analysis aims not only to explore the determinants of economic welfare, but also to test the first hypothesis on the non-linear relationship with WTR. The estimation of economic welfare using the specification from equation (2) is conducted[4]. First, Durbin-Wu-Hausman test (Davidson and MacKinnon, 1993, 235–236) significantly confirms endogeneity of the estimation. Second, the Hausman test (Greene, 2012, p.420) suggests the fixed effects model to be the most suitable rather than the random effects and the OLS regressions. However, some individual time-invariant variables are of interest of this study. While the random effects model is not recommended and fixed effects model eliminates the time invariant variables, a

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[4] Due to the large number of independent variables, a test of multicollinearity (VIF test) is applied on equation 2. Results of the tested are reported in Appendix A, Table A2

correlated random effects model, namely Hausman-Taylor model (Hausman and Taylor, 1981), is chosen. This model allows one or more variables to be correlated with the unobservable effects (Wooldridge, 2010), at the same time, it allows for analyzing the impact of some individual time invariant variables. Among other factors, ethnicity plays an important role in this study.

The results of fixed effects model show an insignificant coefficient of risk attitudes. The question is that whether there are different shapes of the relationship between risk attitudes and economic welfare witnessed by the culturally and socioeconomically diverse sample. Consequently, a "risk-income paradox" suggested by Bouchouicha and Vieider (2017) could exist in our research sample. To test the hypothesis on a non-linear relationship, first, an analysis of predicted values of economic welfare is conducted after a fixed effects regression of economic welfare using equation (2). The two-way quadratic prediction plot of the economic welfare against WTR in Figure 3.3 demonstrates the non-linear relationship between the willingness to take risks and economic welfare among the ethnic minorities. It shows that among the risk-averse individuals who report their willingness to take risks roughly at 3 or lower on the 11-point Likert scale of, the more risk-averse, the better economic condition they have. In contrast, among the individuals who report their risk-taking from that point upwards, the more economically better-off, the less risk-averse they are. Interestingly, the association between risk-taking and economic welfare is positive among the majority group in a monotonic pattern. That suggests a linear relationship between risk attitudes and economic welfare among the ethnic majority group.
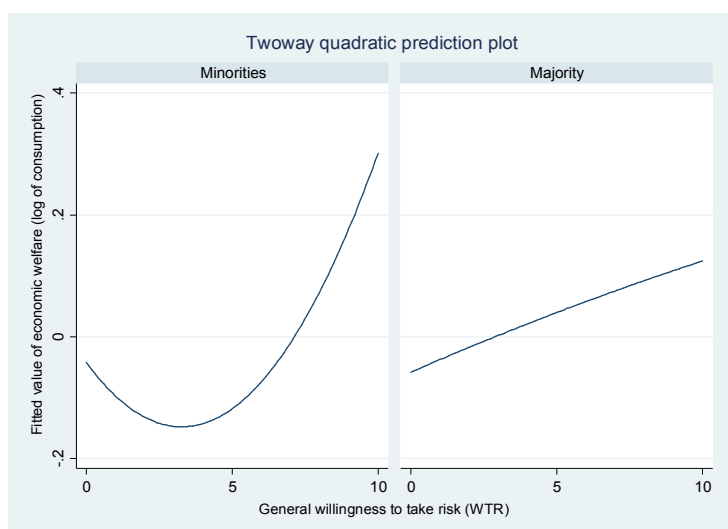
Figure 3.3: Two-way quadratic prediction plot: economic welfare against risk attitudes

Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations

To quantify the non-linear pattern of the relationship between the risk attitudes and economic welfare, a quadratic term of WTR is added to the same regression models. The results are reported in Table 3.3 including the outcomes for the ethnic majority sample and for the minority sample[5]. Attention is especially paid to the significance of the coefficients of both original and quadratic forms of WTR among the ethnic minorities, whereas they are insignificant in the sample of the ethnic majority. Because the sample of the ethnic majority is homogenous regarding cultural and socioeconomic backgrounds, while that of the ethnic minorities including a large number of group (Figure A1, Appendix A) are significantly diverse. The result seems to reflex the driving force of cultural factors in the patterns of the relationship between risk attitudes and economic welfare across cultural groups. It can be that this relationship can be positive in one or more groups but it could be negative in the other groups. For instance, Figure A2 (Appendix A) shows that as largest groups among the ethnic minorities, Ede and Paco are insignificantly different in economic welfare from other groups, whereas Paco's respondents expressed stronger willingness to take risks and Ede's respondents expressed stronger risk aversion.

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[5] The results of the full sample are skipped since they are dominated by the results of the ethnic majority groups due to its larger sample size.

Table 3.3: Determinants of economic welfare

Subsamples (observations):	Majority (1,045)		Minorities (500)	
VARIABLES/MODELS	FE	HTAYLOR	FE	HTAYLOR
Age	0.072***	0.034**	0.097**	0.027
	[0.027]	[0.016]	[0.039]	[0.025]
Age square	-0.001**	-0.0004***	-0.0004	-0.0002
	[0.0003]	[0.0002]	[0.0004]	[0.0003]
Married	-0.003	0.130*	0.336***	0.251***
	[0.115]	[0.069]	[0.127]	[0.095]
Self-employed	-0.097	-0.065	0.245	0.159
	[0.064]	[0.050]	[0.189]	[0.158]
WTR♦	0.005	0.001	-0.062***	-0.057***
	[0.014]	[0.013]	[0.023]	[0.021]
WTR square	-0.001	-0.0001	0.006**	0.006***
	[0.001]	[0.001]	[0.003]	[0.002]
Impairment	0.016	-0.013	-0.029	-0.053
	[0.037]	[0.031]	[0.058]	[0.049]
Membership	0.003	0.011	-0.052	-0.020
	[0.034]	[0.028]	[0.059]	[0.049]
Education (decision maker)†	0.067*	0.065**	0.013	0.116*
	[0.036]	[0.028]	[0.088]	[0.068]
Household size	-0.132***	-0.116***	-0.148***	-0.105***
	[0.021]	[0.016]	[0.029]	[0.021]
Dependency ratio	0.135**	0.179***	0.378**	0.347***
	[0.066]	[0.052]	[0.155]	[0.124]
Nonfarm land [log]	-0.001	0.006***	-0.005	0.004
	[0.003]	[0.002]	[0.004]	[0.003]
Average member age	0.008**	0.007***	-0.008	-0.002
	[0.003]	[0.002]	[0.006]	[0.004]
Average member education	0.027***	0.037***	0.024	0.052***
	[0.007]	[0.005]	[0.015]	[0.012]
Migrating members	-0.027	-0.028	-0.131*	-0.143**
	[0.022]	[0.018]	[0.076]	[0.064]
Literacy	0.032*	0.015	-0.007	-0.007
	[0.019]	[0.014]	[0.028]	[0.022]
Self-employed members	0.054	0.080***	-0.155	-0.011
	[0.034]	[0.027]	[0.137]	[0.111]
Distance to town	-0.003	-0.002	0.001	-0.002
	[0.003]	[0.002]	[0.004]	[0.002]
Water quality	-0.053***	-0.052***	0.0003	-0.002
	[0.013]	[0.011]	[0.022]	[0.018]
Economic shocks	0.034	0.047**	0.045	0.023
	[0.025]	[0.022]	[0.040]	[0.034]
Agricultural shocks	-0.018	-0.032**	0.004	-0.026
	[0.018]	[0.015]	[0.026]	[0.021]
Socio.demo.shocks	0.028	0.019	0.018	0.009
	[0.020]	[0.017]	[0.033]	[0.028]
Stability	-0.0003	0.001	-0.009**	-0.005
	[0.002]	[0.001]	[0.005]	[0.004]
Road quality	-0.047**	-0.045***	0.047	0.054
	[0.019]	[0.017]	[0.045]	[0.039]
R^2 (within)	0.343		0.323	

Notes: Hausman test prefers Fixed Effects, the Hausman-Taylor model assumes endogeneity of (♦) WTR (the willingness to take risks). †: household decision maker has number of schooling years higher than 12. Robust standard errors are in brackets. Control for province, regional and time effects. Other control variables have insignificant coefficients including: health impairment, membership, gender, province, regional variables and time.

Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations.

In the results of the ethnic majority group, the coefficients of the variables that explain significantly economic welfare have similar magnitude compared between the fixed effects model and the Hausman-Taylor model. In particular, the following variables significantly determine household's economic welfare. Age of the decision maker has inverted U-shape association to economic welfare. As such, too old or too young household decision makers tend to be related with worse economic condition of the household. Furthermore, a household is better-off if it has a household decision maker who obtains education that is higher than 12 years of the official schooling years, although the coefficient is only weakly significant. Household size has a negative effect, but number of dependent members has a positive effect on household economic welfare. There is a positive effect of the variable of member average age (i.e. average age of the full sample is 50 years old) on household consumption expenditure. Undoubtedly, the average education of the households' members has positive impact on household's welfare. In addition, some significant effects are found from marital status, number of self-employed members, economic shocks and agricultural shocks. However, these effects are only present in the Hausman-Taylor model.

In comparison to the results of the ethnic majority, those of the ethnic minorities show some difference in the effects of some variables. Such as, the variable of age and its quadratic form turn insignificant in the analysis of the minorities. Better infrastructure proxied by the water supply and road quality[6] significantly increases economic welfare of the ethnic majority but not for that of the minorities. The number of migrating members has a negative and weakly significant effect on economic welfare of the ethnic minorities but no significant effect on that of the majority. There are divergent factors to explain economic welfare when comparing between the ethnic majority and the ethnic minorities. This finding is in line with previous studies (Imai et al., 2011a; Van De Walle & Gunewardena, 2001) that found different economic returns with the same characteristics between the majority and the minorities.

In sum, the findings confirm that there is diversity in the relationship between risk attitudes and economic welfare among a mixed sample of ethnic minorities. In particular, this connection is negative among the extremely risk-averse but turns positive among the more risk-taking. That is similar to Bouchouicha and Vieider (2017) who found difference in the direction of the association between income and risk tolerance across cultures (i.e. countries). In contrast, among the homogenous ethnic majority group, no significant coefficient of risk

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[6] These variables are measured by decreasing scales

attitudes is found. To respond, in the next step, this study aims to examine a suggestion from Tanaka et al. (2010) and Cardenas and Carpenter (2013) that there might be simultaneous relation between risk attitudes and economic welfare. It this simultaneity exists, it challenges the results of single-equation estimation.

3.5.3 Simultaneous estimation of risk attitudes and economic welfare

If there is a mutual interaction between risk attitudes and economic welfare, the strict assumption on the exogeneity of the regressors in a static fixed effects regression (Table 3.3) is violated. That causes a correlation between risk attitudes and the error terms of the estimate of economic welfare in a single-equation method. Therefore, this section is going to test a possibility of existing reverse causation between risk attitudes and economic welfare.

We estimate simultaneously economic welfare and the risk attitudes using the system of equations $(3a, b)$ under the 3SLS regression. The results of the full sample are presented in Table 3.4. The tests of assumptions on a consistent and efficient estimation musing 3SLS are positive (details of the tests reported in Table A3 (Appendix A). In particular, in comparison with the single-equation estimations, the signs of these coefficients remain consistent, whereas the magnitudes significantly change. Indeed, taking note of the endogeneity caused by the mutual relation between the WTR and economic welfare considerably changes the coefficients of several variables.

The results indicate that a stronger willingness to take risks is associated with higher economic welfare, i.e. the wealthier an individual is, the more willing to take risks it is. *Ceteris paribus*, an increase in WTR by one point on the 11-point Likert scale is associated with approximately 9% increase in economic welfare. Similarly, one percent increase in consumption expenditure goes along with a 0.7 point increase in the willingness to take risks on the 11-Point Likert scale. The degree of the effect from risk taking on economic welfare is stronger than that of economic welfare on risk-taking. The coefficient of ethnicity in correlation with the economic welfare confirms the ethnic economic gap. *Ceteris paribus*, an ethnic majority household's consumption expenditure per adult equivalent is about 23 percent higher than that of an ethnic minority counterpart.

Table 3.4: 3SLS estimates of economic welfare and risk attitudes

Variables	Economic Welfare (1) Coefficients	Std. Err.	WTR (2) Coefficients	Std. Err.
Willingness to take risks (WTR)	0.090***	0.027		
Daily consumption per adult equivalent#			0.745**	0.378
Age	0.027***	0.009	0.004	0.050
Age square	-0.0003***	0.0001	-0.00003	0.0005
Female	-0.005	0.031	-0.102	0.165
Married	0.115**	0.046	0.411*	0.247
Majority (Kinh)	0.211***	0.035	0.220	0.203
No religion			0.297**	0.147
Self-employed	-0.009	0.047	0.294	0.207
Health impairment	-0.066**	0.033	-0.216	0.178
Member of a social or political org.	-0.013	0.028	0.142	0.149
Education[a]	0.069***	0.024	0.051***	0.020
Household size	-0.078***	0.011	0.027	0.057
Dependency ratio	0.229***	0.051	-0.544**	0.266
Optimistic about future wellbeing			0.571***	0.107
Nonfarm land (log of value)	0.008***	0.002		
Average age of members	0.005***	0.001		
Average education of members	0.038***	0.005		
Migrating members	-0.015	0.018		
Literate members	0.002	0.011		
Self-employed[b]	0.120***	0.025		
Economic shocks	0.061***	0.024	0.129	0.129
Agricultural shocks	-0.055***	0.015	0.162**	0.082
Socio-demographic shocks	0.031*	0.018	-0.162*	0.095
Stability	0.001	0.001		
Distance to town	-0.0005	0.001	-0.009	0.006
Water quality (decreasing scale)	-0.029***	0.009		
Road quality (decreasing scale)	-0.005	0.017		
Coastal	0.129***	0.037		
Mountainous	0.016	0.029		
Hue	-0.418***	0.050	1.671***	0.174
Constant	0.452**	0.228	0.168	1.160
Observations	1499		1499	
R^2	0.403		0.266	

Notes: The Three Stage Least Squares estimation (3SLS). #: Log base ten. [a]: (1): if household decision maker has higher education than high school, (2): number of schooling years of the household representative. [b]: (1): number of self-employed members in household, (2): if the household representative is self-employed. Control for province and time fixed effects. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations

However, there is no significant ethnic difference in the willingness to take risks in this analysis. This implies that the economic gap between the two groups could probably absorb the difference in risk attitudes. The ethnicity can play a role in shaping the relationship between risk attitudes and the economic gap between the majority and the minorities. Therefore, when controlling for the relationship between risk attitudes and economic welfare, the significant difference only remains in the economic welfare but not in the risk attitudes. Some ethnic dimension of this relationship can be discovered by analyzing two groups separately. Nevertheless, provided that among the ethnic minorities, the relationship between risk attitudes and economic welfare has a non-linear shape, the results of this pooled sample

could be subject to some bias. To consider that, an ethnic disaggregating analysis is necessary with emphasize on the ethnic majority group.

3.5.4 Ethnic disaggregating simultaneous equations estimations

This section deals with separate analyses of the ethnic majority and the ethnic minorities using a similar technique that was applied in previous section to the full sample. Purpose of this analysis is to generate insights into the difference in the relationship between risk attitudes and economic welfare within groups.

Results of the above-described analysis are reported in Table 3.5 and in Table A5 (Appendix A) separately for the ethnic majority and the ethnic minorities, respectively. The overall results indicate a large difference between the majority and minorities. The variations of risk attitudes and economic welfare remain well-explained among the ethnic majority; whereas there are fewer significant factors in the economic welfare and risk attitudes the minority group. Probably, mixing different ethnic groups who have different cultures and practices might increase the individual unobserved heterogeneity.

As expected, the significant association between risk attitudes and economic welfare is significant among the majority while it is insignificant among the ethnic minorities. These results reconfirm a positive relationship between risk attitudes and economic welfare among the culturally homogenous ethnic majority. One point increase on the 11-Point Likert scale of in the willingness to take risks associates with roughly 7% increase of consumption. The effects of both risk attitudes and economic welfare on each other reduces in comparison with the results of the full sample in Table 3.4 Especially, the coefficient of economic welfare in the regression of risk attitudes turns statistically insignificant. This implies the method of simultaneous equations is not a proper method to observe the relationship between risk attitudes and economic welfare among the ethnic minorities. Unfortunately, due to limited sample size, further break-downs could not be applied to see the difference across the ethnic minority groups.

Table 3.5: 3SLS estimates of economic welfare and risk attitudes, ethnic majority

Variables	Economic Welfare (1)		WTR (2)	
	Coefficients	Std. Err.	Coefficients	Std. Err.
Willingness to take risks (WTR)	0.067***	0.024	-	-
Daily consumption per adult equivalent#	-	-	0.566	0.489
Age	0.034***	0.011	-0.050	0.070
Age square	-0.0004***	0.0001	0.001	0.001
Female	0.025	0.034	-0.284	0.202
Married	0.148***	0.054	0.472	0.334
No religion			0.438**	0.204
Self-employed	-0.036	0.047	0.329	0.227
Health impairment	-0.036	0.038	-0.301	0.223
Member of a social or political org.	0.012	0.031	0.102	0.186
Education[a]	0.052**	0.025	0.062**	0.026
Household size	-0.094***	0.016	0.013	0.082
Dependency ratio	0.230***	0.055	-0.816***	0.314
Optimistic about future wellbeing			0.747***	0.136
Nonfarm land (log of value)	0.007***	0.002		
Average age of members	0.006***	0.002		
Average education of members	0.034***	0.006		
Migrating members	-0.013	0.018		
Literate members	0.007	0.014		
Self-employed[b]	0.125***	0.025		
Economic shocks	0.080***	0.027	0.089	0.168
Agricultural shocks	-0.041**	0.018	0.137	0.109
Socio-demographic shocks	0.008	0.020	0.014	0.119
Constant	0.652**	0.306	1.710	1.752
R^2	0.370		0.243	
Observations	1013		1013	

Notes: The Three Stage Least Squares estimates (3SLS). #: Log base ten.:[a] (1) & (3): if household decision maker has higher education than high school, (2) & (4): number of schooling years of the household representative. [b]: (1) & (3): number of self-employed members in household, (2) & (4): if the household representative is self-employed. Control for village level characteristics, province and time effects. Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.
Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations

Similar to the results of single-equation estimation in section 4.2, the results of the simultaneous equations estimation document divergent determinants of risk attitudes and economic welfare. First, to some extent this difference reveals the structural variation in economic welfare between the majority and the ethnic minorities as shown in other studies (e.g., Imai, Gaiha, & Kang, 2011a; Van De Walle & Gunewardena, 2001). However, because of the switch in direction of the relationship between risk attitudes and economic welfare that is not controlled for the results could be biased. The results of the ethnic minority group are reported in the Table A4 in Appendix A for reference only. In addition, adding the quadratic term of WTR (Table A5) demonstrates a positive significant correlation but the assumption of over-identification does not hold, consequently the results are biased.

To sum up, a significant effect of the willingness to take risk on economic welfare is found when allowing a bidirectional relationship between the WTR and economic welfare when analyzing the group of ethnic majority. That explains why the single equation estimation

method in section 4.2 could not find a significant explanation of risk attitudes towards economic welfare because the reverse causation that exists in this relationship was not controlled for. The insignificant correlation between risk attitudes and economic welfare in the group of the ethnic minorities confirms a non-linear pattern of this relationship when considering ethnic minorities and the majority jointly. Furthermore, largely different determinants of the economic welfare and the WTR found between the majority and ethnic minorities seem to be consistent in comparison between the single equation method and the simultaneous equations method.

3.6 Conclusions

This study examines the relationship between the risk attitudes and economic welfare in the presence of high ethnic diversity among rural farmers in Vietnam. First, the measure of general willingness to take risks is empirically validated for its reliability and applicability. Second, different approaches are used to explore the complexity of the relationship between the risk attitudes and economic welfare among a strongly heterogeneous population. Ethnic disaggregation aims to compare between two ethnic groups, namely the ethnic majority and the ethnic minorities.

The survey-based measure of risk attitudes could sufficiently measure risk attitudes in the presence of the ethnic diversity. The overall results indicate that cultural factors characterized by ethnicity do shape a large variation of risk attitudes and economic welfare. The results demonstrate an ethnic gap in economic welfare such that the ethnic majority is wealthier in terms of different economic indicators. Additionally, they express stronger willing to take risks than the ethnic minorities. Diversity is even found among the ethnic minorities. For instance, the largest ethnic minority group, Ede, reported significantly weaker willingness to take risks in comparison to other ethnic minorities, while their economic welfare is similar to other minority groups.

Results explain to some extend the mixed empirical results concerning this relationship in previous empirical studies by indicating that ethnicity alters the interdependency between risk attitudes and economic welfare. First, the results for the ethnic minorities indicate a switch from a negative to a positive relationship between risk attitudes and economic welfare when the willingness to take risks increases on the 11-point Likert scale. This finding confirms the mixed results on the relationship between risk attitudes and economic welfare when comparing across countries or cultures in which risk attitudes significantly diverges. Second, this study provides evidence of a positive and mutual relationship between risk attitudes and

economic welfare among the socially and culturally homogenous and ethnic majority group. However, only the effect of risk attitudes on economic welfare is statistically significant. Particularly, one point increase in the willingness to take risk scale associates with about 7% increase in economic welfare. This finding is in line with a conventional negative linkage between risk aversion and economic welfare among the poor in developing countries. Additionally, this mutual interrelationship challenges the consistency of the results from the single-equation estimation method applied elsewhere in literature.

Between the two ethnic groups, divergent determinants of economic welfare and the individual willingness to take risks are documented. For instance, while minorities are more vulnerable to risks due to their socio-demographic characteristics, resources such as non-farm land and non-farm self-employment are prominently beneficial to the ethnic majority. Additionally, some difference between Ede (i.e. the largest minority group) and other ethnic minorities suggests further diversity within the group of ethnic minorities. This implies a need to consider simultaneously the ethnic heterogeneity and risk aversion in socioeconomic policy making to enhance economic development and poverty alleviation in such ethnically diverse populations. For example, among the extremely risk-averse ethnic minority individuals, interventions to improve economic welfare can be only effective conditional on encouraging their risk-taking. This study should be replicated for other ethnically diverse populations to assess the role of risk aversion in economic development in multicultural populations with recognized inequality. Finally, the correlated error terms in the system-equation analysis suggests a dynamic relationship between risk attitudes and economic welfare that leaves room for future studies.

CHAPTER 4

FARMERS' RISK ATTITUDES, KNOWLEDGE, SKILLS AND AGRICULTURAL PRODUCTIVITY

Agriculture is a risky business contingent on risks and uncertainty. Without strong technical knowledge, farmers tend to rely heavily on heuristics and subjective judgments to deal with their daily business. It is crucial to understand farmers' practices to provide suitable supports. In this chapter, we use rich data from a long panel household survey to assess farmers' agricultural productivity in Hue province of Vietnam that we combine with data collected from special surveys conducted in 2014 and 2015 focusing on farmers' knowledge, skills and risk attitudes. It aims to provide an overview of the environment in which farmers do business under constraints. Particularly, we investigate the relations among risk attitudes, farmers' knowledge, management ability and agricultural productivity by using univariate and bivariate analyses. The results indicate a large variation in farmers' knowledge but most of them have low degree of technical and subjective knowledge. Agricultural performance tends to be more dependent on subjective knowledge than technical knowledge. Farmers received limited support from the extension institutions, while they are more likely risk-averse. Farmers have stronger knowledge and decision-making ability in livestock than in crop production. While risk attitudes are significantly correlated with farmers' knowledge and decision-making ability in livestock production, it has no direct significant relation with agricultural performance. The previous outcome showed that livestock productivity is prone to fluctuation, risk-taking should be important for farmers to cope with shocks. This study suggests extension services to fill the gap between the subjective knowledge and technical knowledge and to bridge a significant linkage between risk-taking and learning to improve farmers' abilities and consequently enhance agricultural productivity.

4.1 Introduction

The famous T.W. Schultz hypothesis (Schultz, 1975) has established that farmers in developing countries are "poor but efficient". From experience and heuristics, indigenous knowledge farmers tend to find the best possible solutions, which have emerged for specific farming environments for the conditions under which they operate. However, inefficiency can occur when the conditions under which farmers have been operating change. This can happen when the farming environment changes due to political, economic and environmental factors. One such example of political and economic change is the Doi Moi reforms in Vietnam

during the nineteen eighties, which have led to an impressive increase in productivity and total output especially in Vietnam's rice economy. New technologies, access to yield increasing inputs and extension information has enabled farmers to quickly find new optima and produce efficiently. However, some regions in Vietnam such as the Northern and Central Highlands did not equally benefit from this development (e.g., Kyeyune & Turner, 2016). Farmers in these regions often had to rely on own experience and subjective knowledge when adopting new technologies and adjusting their farming systems to altered environmental conditions such as climate change. Hence, farmers in these regions are confronted with higher costs of information and with higher risks. In this study, we therefore investigate the relationship between knowledge, risk and agricultural productivity of farming in one province of the Central Highlands in Vietnam, namely Thua Thien Hue (Hue).

To perform our analysis, we use long-term panel data covering the period from 2007 to 2015 of some 700 rural households in 70 villages in the province of Hue[7]. Data on annual crop yields, and productivity of livestock enterprises allowed us to calculate the average yield and net revenue by enterprise per farmer. Furthermore, we performed a number of tests on farmers' agricultural knowledge, their decision-making (management) abilities, their cognitive skills and their level of confidence in making decisions in farming and related businesses. We try to answer three questions; first, do farmers with higher knowledge and skills show a higher farming performance than those with lower capabilities? Second, we analyze whether farmers with higher knowledge and skills are also those who are willing to take more risks. Third, we want to know if there is a positive relationship between farmers' higher willingness to take risk and their economic success in agricultural production.

The data used in this study are apart from the Thailand Vietnam Socio economic panel (TVSEP) data which have been collected by a comprehensive socio-economic survey with some 4000 rural households in three provinces of Thailand and three provinces of Vietnam since 2007. In particular, data from one province in Vietnam namely Thua Thien Hue (Hue) are employed. In this province, in addition to the household surveys, we have carried out two complementary surveys in 2014 and 2015 on knowledge, risk attitudes and decision-making of the farmers who are respondents of the panel. More specifically, this special survey included a detailed set of knowledge questions; survey risk items and risk experiment were

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[7] Due to the attrition rate, the sample size reduced to roughly 620 households in 2015

applied. Furthermore, decision-making games were applied to capture the farmers' management ability.

To answer our research questions, a stepwise approach applying descriptive analyses using both univariate and bivariate method is applied. In the first step, the measures that were used to evaluate farmers' knowledge, skills and attitudes are analyzed separately. In the second step, the relations among farmers' knowledge, skills and attitudes are examined by applying non-parametric tests. Finally, an investigation in the relation between agricultural production and farmers' capacity proxied by their knowledge, their ability and their attitudes to risks is introduced.

The results show that in general farmers have low knowledge in crop and livestock production. That is indicated by both tests and their own self-assessment. The farmers expressed their confidence in decision-making however they performed less precisely in decision-making games and they are less likely to have economic logic for their decisions. At the same time, they tend to be risk-averse, meanwhile not many of them and not often received external support regarding extension visits and training. As a consequence, their agricultural performance is shown to be stronger correlated with subjective knowledge rather than with tested technical knowledge and management ability. Regarding personal skills, farmers' cognitive skills are correlated with crop productivity but not with livestock production significantly. In the results of bivariate analyses, in regards to the relationship between risk measures and knowledge, risk-taking is correlated with knowledge and decision-making skills in livestock production positively and significantly but less likely with those in crop production. Furthermore, the results show an increasing trend in the average farming performance in the province of Hue, both crop production and livestock production. Additionally, it is observed that livestock production is more fluctuated over the years, whereas rice yield is considerably stable. In summary, to our best knowledge, this study is the first attempt to establish empirical evidence on the interplay of risk and knowledge for the success of farming in developing countries.

This chapter proceeds as follows. In the next section, we briefly review the literature on knowledge and risks in farming in order to underpin our hypotheses. A description of the data and univariate analyses for the important variables are included in section three. Section four presents the bivariate analyses and test results of the relations of knowledge, skills and management capacity with farm productivity parameters. It is followed by the analysis of the relationship between agricultural performance and individual risk attitude. Finally, the fifth

section reports a summary, a conclusion as well as a discussion on possibilities for advancing the analysis.

4.2 Theoretical background and literature review

Knowledge and learning have long been recognized as essential factors of production aside from the conventional inputs like capital, land and labor. With the introduction of the endogenous growth theory (e.g., Romer, 1994) knowledge has been formally included in the economic growth models. In recent economic researches (e.g., Helman, 2009), knowledge is being considered as the major input variable.

In agricultural development, the role of "learning-by-doing" was established as an important factor that influences farmers' technology choice decisions (Foster & Rosenzweig, 1995). Social scientists who work on agriculture (e.g., Stone, 2016) have developed a theory of farmer's learning taking into account multiple actors that shape farmers' knowledge.

The approach of incorporating knowledge into the models to explain productivity and efficiency in agriculture has been well documented in the literate of technology adoption (e.g., Jamison and Moock, 1984; Feder et al 1985, Stefanou & Saxena, 1988; Adesina & Djato, 1996). In this literature strand, variables such as education, experience, numeracy ability and the frequency of extension contacts are considered as the major determinants of adoption and farm performance. More recently, with the introduction of information technology, for example precision agriculture (e.g., Fountas, et al., 2006) the importance of technical knowledge and management in the agricultural production process has increased.

Hence as pointed out by Rougoor et al. (1998) more studies that include studies on the aspects of farmer's decision-making process are needed. In their paper, Rougoor et al. (1998) specified management capacity as a factor that could explain a considerable proportion of farm outcomes. The study confirmed management as the fourth production factor and concluded that the mechanisms are still poorly understood as mostly formal education has been used as the major explanatory variable.

Furthermore, the role of agricultural knowledge institutions where famers are not solely recipients of information but are part of an innovation system (e.g., Weyori et al., 2018). Farmer participation has been well documented for example in the popular and widespread Farmer Field Schools (FFS) approach in developing countries. FFS was a method of experiential learning to generate in-depth knowledge, which is based on the understanding of the biological, technical and economic components in agriculture and thus facilitating judicious and reasoned decision-making. Tripp et al. (2005) in their study from Sri Lanka

provided evidence for the generation of knowledge and understanding of the rice ecosystem and farmers' skills could help to lower uneconomical insecticide use.

In conclusion, a dearth of literature strongly underlines the importance of knowledge in explaining farming and farmers' performance. Considering the advancement of information technology among small-scale farmers in Asia including smart phones (Hübler, 2016; Hübler & Hartje, 2016), the knowledge as a factor of production will grow relative to the traditional production factors like capital labor and land. Following the findings of the recent literature that suggests going beyond the simple education variable to capture knowledge and management capacity in the design of this study, we therefore have incorporated a set of procedures that aimed at measuring knowledge and decision-making capacity, from both technical-objective and a subjective perspective. First, in the 2014 and 2015 surveys (see next section for details), the respondents were confronted with a set of six standard cognitive skills questions related to simple calculus and logic with multiple-choice answers. Second, knowledge tests were included for technical knowledge. A set of ten knowledge questions are applied for crop and livestock production respectively in the form of two-answer choice, i.e. right or wrong. These sets of questions enabled us to establish a knowledge score ranging from zero to ten for every respondent. Third, the respondents were asked to self-assess their knowledge in crops, livestock and business management by selecting a point on a five Likert-scale, ranging from very poor to excellent. We asked: "How would you rate your knowledge in crop, livestock and farm business" (labor allocations, machinery, land use, finance)? We included this question because subjective knowledge is important as farmers have their own observations based on experiences in their agro-ecological and agro-economic environment, which may not necessarily correspond with the often highly partial and single-factorial knowledge packages promoted by agricultural extension services. The fourth test we included in the surveys was a decision making test, again separately for crops and livestock. Here we confronted famers with a management choice, i.e. two rice varieties and two livestock breeds that differed in output, product price and input costs. One alternative was clearly economically dominant in terms of net revenue. Farmers who made the right choice and gave a plausible reason, i.e. the net revenue or profit, passed the test with distinction. Respondents who made the correct choice but had no plausible reason for it received 1 score and the remainder of respondents zero score, i.e. they failed the test. Finally, we asked respondents to assess their confidence in making farm decisions. *"Do you feel confident (i.e. you are sure that you always make a good decision when you make a decision in agriculture (examples: given were: choice of variety, planting time, applying fertilizer, spraying pesticides, purchase of livestock)"*? Similarly, a five point Likert- scale was used ranging from "never confident to

always confident. The confidence score was interpreted as a subjective indicator of decision-making capacity (i.e. "to know what you are doing").

In summary, the knowledge and skills tests included in our surveys are believed to provide a more advanced measure of human capital than the usual formal education questions common in most studies on farmer knowledge. Most importantly, our measures at least have a notion of capturing the decision making process albeit still in an imperfect way.

While knowledge is an important factor in explaining technology adoption and efficiency in farming, another factor is risk behavior. In studies of technology adoption in developing countries risk attitude has often been a significant explanatory variable (e.g., Baidu-Forsen 1997).

However, little is known about the relationship between knowledge, decision-making ability and willingness to take risk. Thus, we briefly review the literature on risk in relation to the knowledge and decision-making. Marra et al. (2003) have provided a useful state-of-the-art in their paper: *"the economics of risk, uncertainty and learning in the adoption of new agricultural technologies: where are we on the learning curve",* the authors emphasize the importance of distinguishing between risk and learning for a correct understanding of technology adoption processes. They point out that aside from risk perception, farmer's attitude towards risk and the farmer's way of experimentation is relevant to understand technology adoption. A more recent example of the role of risk perception is given in a study about weather risks in apple production (Menapace et al., 2012). The authors confirm once again that famers are risk-averse decision makers. But they also show that risk attitude can affect subjective assessments of production losses due to weather events. Hence, the relationship between risk attitudes and subjective knowledge should be considered when analyzing farm outcomes. Willock et al. (1999) also emphasized the need to integrate socio-economic, technical and psychological variables into a framework to analyze farmer decision making and outcomes.

In Vietnam, there have been prominent studies on farmer behaviors with regards to risk attitude and time preference (e.g., Tanaka et al., 2010). A number of studies have analyzed the role of agricultural extension services in Vietnam especially in the process of de-collectivization initiated by the Doi Moi policy (e.g., Castella et al., 2006). The study showed that large disparity exists within farmer communities concerning access to technical information and other agricultural services namely input subsidies. This was also confirmed in a recent study by Minh et al. (2015) although the prospects towards a more demand-driven

and need-based extension approach were shown to slowly emerge. Both studies suggest that we can expect a considerable variation of farmer knowledge within our sample.

Hence, in our 2014 and 2015 survey, we have included three risk items, namely (1) the standard Dohmen et al. (2005)'s survey question, (2) a hypothetical investment question and (3) a Holt-Laury's (2002) type risk experiment (see Appendix B). The self-assessed question and the hypothetical investment were asked in the middle of the questionnaire, while the risk experiment was conducted upon the completion of the questionnaire. By doing so, we tried to avoid the "forced correlation" as suggested in Hardeweg et al. (2013). The risk game was designed in Dohmen et al. (2005) and the outcomes of this game was found to be correlated with the self-assessed question among German sample (Dohmen et al., 2010) and among Thai sample (Hardeweg et al., 2013).

Follow the literature review on the relationship between knowledge, farmers' capacity and risk attitude and farming performance, we can derive hypotheses for this study. Firstly, in the absence of formal training and system learning, farmers' knowledge could be widely diverse in case of farmers in Hue province. Secondly, we assume that farmers in our sample tend to be risk-averse that might lead to limitation in technology adoption and knowledge. Hence, farmers could be more dependent on their subjective knowledge than their limited technical knowledge. Compared to crop production, livestock production plays an important role not only for income but also to cope with shocks (Do et al., 2017), farmers might have stronger knowledge and skill in livestock production than in crop production. Hence, thirdly, we expect some linkage between risk attitudes and knowledge, consequently lead to farming performance.

4.3 Data and descriptive results

This section firstly introduces our sample in the frame of a long panel survey. Secondly, the important measures of knowledge, skills and farm performance are summarized and analyzed by a univariate method.

4.3.1 Data

The data used in this project have been collected in the frame of the "Thailand Vietnam Socio Economic Panel" (TVSEP, www.tvsep.de) and its predecessor projects. Under this frame, rural household and village surveys have been carried out among some 4000 households and 440 villages and six provinces in Thailand and Vietnam since 2007 (Hardeweg, Klasen & Waibel, 2013). The sample is representative for rural areas in Northeast Thailand and Central

Vietnam. The sample strategy consists of a 3-stage cluster sampling design. In the first sampling stage, provinces were chosen purposively with criteria such as average per capita income, poverty headcount ratios, dependence on agriculture, remoteness and peripheral locations and poor infrastructure, i.e. overall provinces that had villages located in risky environments. In the second step, the sample was taken proportional to population size of all rural sub-districts (communes in Vietnam) in a province. From each sub district (commune), two villages were selected at random and within a village, ten households were chosen following a systematic-random sampling procedure by ordering households by their size. In Vietnam where the three provinces are heterogeneous regarding agro-ecological conditions and population density, e.g., lower densities in mountain areas and higher density in lowland areas additional strata was used. For two provinces namely Ha Tinh and Thua Thien Hue (Hue) the province was divided into coastal, lowland and upland areas while in Dak Lak province due to the absence of access to the sea only lowland and upland strata were defined. In order to allow meaningful analysis sample the sample size was fixed at a minimum of 160 households per location strata. Data for the local administrative units and household sample frames were taken from the Agricultural and Rural Census 2006, conducted by the Vietnam General Statistical Office (GSO). Because stratification in the provinces of Vietnam results in an imbalanced sample of the rural population of the three provinces, it requires sampling weight for the analysis.

In this study, we use the data from the province of Thua Thien Hue that is located in the central part of Vietnam. The province of Hue ranges from the South China Sea in the east to the Laos boarder in the west and has three distinct zones, namely coastal, lowland and mountain zones. For our analysis, we have panel data from some 700 households in 70 villages from seven survey waves, namely 2007, 2008, 2010, 2011, 2013, 2014 and 2015. The survey waves 2007 until 2011 and 2013 were regular comprehensive household and village surveys. The survey instrument included information on household and individual characteristics, all income generating activities including farming, wage employment and non-farm self-employment, transfer income, debts, consumption expenditures and assets. Detailed data were collected on all agricultural activities of the household including yields, production costs and sales prices for crop and livestock products. Furthermore, subjective information on shocks and risks as well as individual risk attitudes had been elaborated.

In 2014 and 2015, special surveys were conducted in Hue province with the respondents of the panel. The surveys focused on risk, financial literacy agricultural knowledge and decision-making skills in agriculture and related business and only included some components of the

income generating activities, i.e. input and output data for crop and livestock. The data used in this study are not constrained to the identical respondents between 2014 and 2015; instead, we use all the observations in both years. Slightly more than haft of the respondents who participated in both surveys, the rest are most likely spouses of the household heads. As a result, almost 90% of the respondents are either the household heads or the spouse of the head; this proportion is similar in two surveys.

4.3.2 Univariate analysis of the measures

This section introduces the measures of farmers' attitudes, knowledge and skills, including risk attitudes, technical and subjective knowledge, decision-making and cognitive skills. That is followed by the summary of the results of those measures. In addition, this section presents the calculations of agricultural productivity and the extensions services that households experienced. Finally, the relationship between farmers' knowledge and skills and agricultural productivity is analyzed by a descriptive method.

4.3.2.1 Risk attitudes

To assess the risk attitude of the respondents, three risk items were included in the 2014 and 2015 studies. First, the Dohmen et al.'s (2011) survey-based risk item, where respondents are asked to classify themselves on an eleven-point Likert scale with the standard question: "*Are you generally a person who is fully prepared to take risks, or do you try to avoid taking risks? Please choose a number on a scale from zero (unwilling to take risks) to ten (fully prepared to take risks)*". Second, we had a hypothetical investment question where we asked the respondents about the sum of money they would be willing to invest in a high return but high risk investment. The question was as follows: "*Imagine you had just won 60 Mio. Dong in a lottery and you can invest this money in a business. It is equally likely that the business goes well or not. If it goes well you can double the amount invested after one year. If it does not go well you will lose half the amount. What fraction of the 60 million VND would you invest in the business?*" Third, we conducted a Holt and Laury (2002) incentivized experiment with real payouts (Appendix B). Respondent were asked to choose between with a safe payoff and a lottery of 200,000 VND (about 10 USD in 2014) with a 50% chance of winning. The choices were displayed on a table with 20 rows. Safe pay-offs were increased in steps of 10,000 VND and respondents could choose the point (switching row) where they would prefer the safe amount to the lottery. To assure that the incentive reveals actual preferences respondents had to draw a random number between 1 and 20. Results of the random draw determined whether the lottery would be played or the respondent would receive the safe

amount. In case the random number drawn was below the respondent's switching point, the lottery would be played by tossing a coin. The safe amount would be paid if the random number was higher than the switch point.

Results of the three risk items confirmed the previous finding in the literature that farmers in developing countries tend to be risk-averse. In Figure 4.1, we report the finding from the survey risk item in 2014 and 2015. We can see that the majority of respondents choose a number of 5 or lower (risk-averse) while a much lower number chose a number of 9 or 10 (strongly risk-taking).
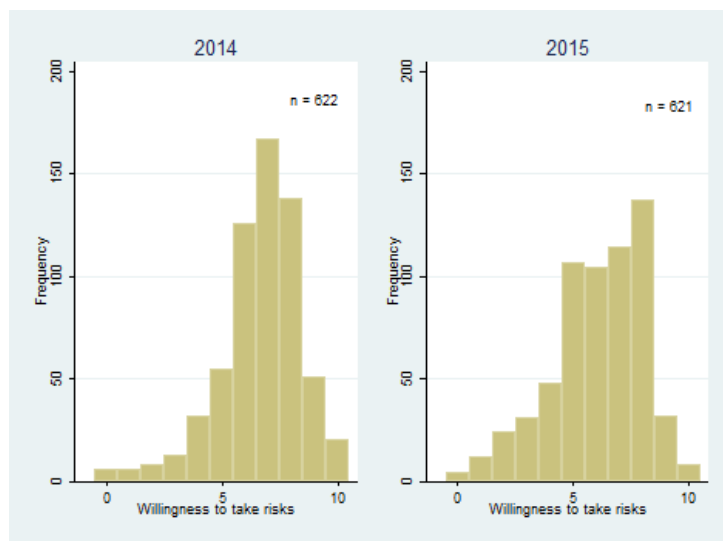
Figure 4.1: Frequency distribution of the willingness to take risks (WTR)

Note: 2014 with 622 observations and 2015 with 621 observations. The willingness to take risk uses 11-Point Likert scale

Source: Special surveys in 2014 and 2015, own calculations

From the second risk item of the hypothetical risky investment, we find similar results. In Figure 2, we show the frequency distributions of farmers' investment choices in steps of 10 million VND. The distributions show that in both 2014 and 2015 most respondents chose the middle column that is equivalent to 30 million VND. A small number of respondents chose the largest amounts of 50 or 60 million VND (i.e. the whole amount of money) to express their strong willingness to take risks. That is similar to the results of the willingness to take risks in Figure 1 that most of the respondents tend to be risk-averse, whereas few respondents are strong risk lovers.
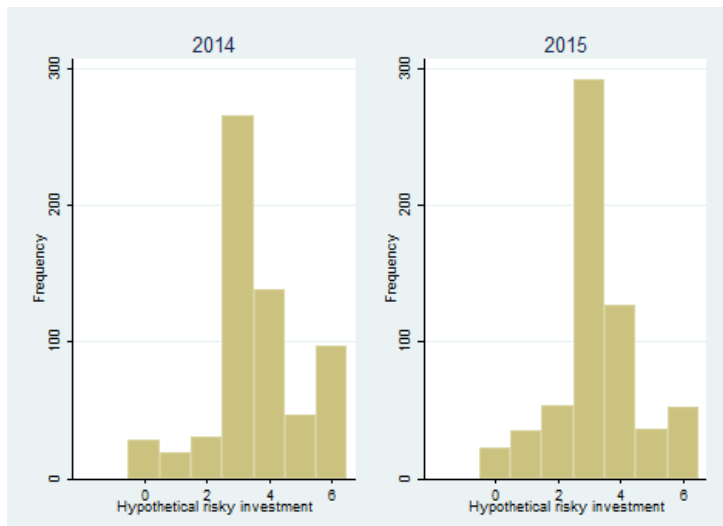
Figure 4.2: Frequency distribution of the hypothetical risky investment (INV)

Note: investment amount in steps of 10 million VND. 2014 with 622 observations and 2015 with 621 observations

Source: Special surveys in 2014 and 2015, own calculations

Results of the risk experiment, the third measure of risk attitudes, are presented in Figure 3. Roughly speaking, the distributions of income are similar between two years. Only is the difference between the two years regarding the respondents who expressed their extreme risk taking by switching at the last row or never switch (i.e. both two cases are treated similarly) that is considerably higher in 2014. In both years, the highest column belongs to the row 11th that represents the risk neutral individuals. In both years, most respondents showed their risk aversion by switching before the row 11th.
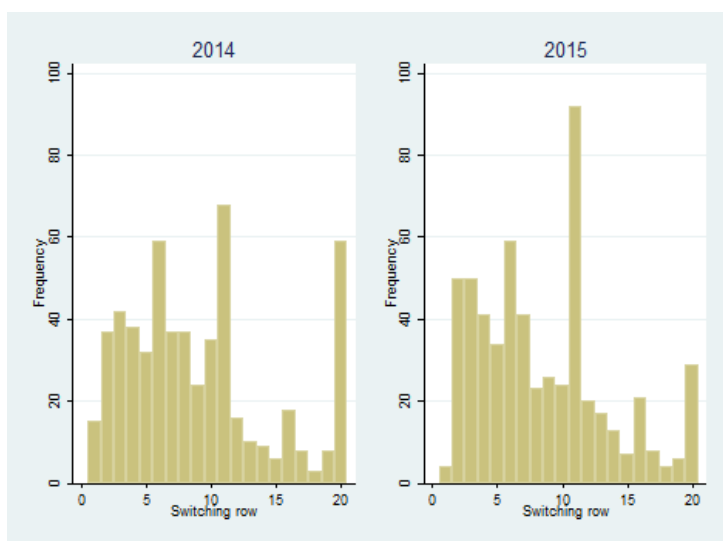
Figure 4.3: Frequency distribution of the switching row in risk experiment (SR)

Note: 2014 with 622 observations and 2015 with 621 observations

Source: Special surveys in 2014 and 2015, own calculations

To sum up from three measures of risk attitudes, most farmers in our study sample show their risk aversion that confirms the most common finding in literature about the risk preferences of the farmers in developing countries.

4.3.2.2 Technical and subjective knowledge

To measure the level of technical knowledge in agriculture of the farmers in Hue province, we performed a knowledge test with the respondents in the 2014 and 2015 surveys. The knowledge test consists of ten technical questions for crops and livestock respectively (Appendix B). The answers were unambiguous so that respondents could give either a correct or a wrong answer and a knowledge scale from zero to ten could be derived. We included a self-assessment question (Appendix B) for knowledge whereby respondents were asked to assess their knowledge in crop, livestock and general farm management decision-making on a five point Likert scale ranging from "very low" to "excellent". In addition, using a five point scale, we asked the farmers to what extent they feel confident when making farm decisions ranging from "never, often not, sometimes, mostly and always confident". The results showed that farmers' formal technical knowledge in agriculture is generally low while their subjective assessment of their knowledge is better. Both set of questions were meant to measure farmer's knowledge and confidence based on own experience and indigenous knowledge complementary to the one conveyed by extension services.

The knowledge test results are presented in Table 4.1. Even though there is no farmer who has score at zero, many farmers have low score (from 5 down), in particular in crop production. In the crops knowledge test in 2014 only slightly above 20% of the farmers reached a score above 5, i.e. answering more than a half of the knowledge questions. In 2015, the number of farmers got a score higher than 5 increases to roughly 50% (see Table 4.1) albeit almost half of the farmers still remained their low scores. Compared with knowledge in crop, farmers show better knowledge in livestock production evidenced by significant higher scores in livestock production in both years. Interestingly, the scores in crop production improved dramatically, whereas the scores in livestock production only slightly improved in the two highest categories. Probably, farmers who received extension services might improve their knowledge during the time between two surveys.

Table 4.1: Distribution of test scores for technical knowledge crop and livestock

Year	2014		2015	
Score category/Knowledge Area	Crops (%)	Livestock (%)	Crop (%)	Livestock (%)
1-5	78.4	23.9	41.9	22.3
6- 8	21.2	69.8	52.8	70.3
9-10	0.4	6.3	5.3	7.4

Note: score is measured by counting the number of correct answers to a set of ten questions.

Source: Special surveys in 2014 and 2015, own calculations

As shown in table 4.2, most often farmers self-assesses that they have moderate knowledge in all areas. Few farmers confidently reported their strong knowledge in all areas of knowledge that was asked. Compared with the strongest point, significant more farmers stated their very low knowledge. There is some similarity between the tested knowledge and self-assessed knowledge that most farmers have limited knowledge in agricultural production. In addition, similar to the tested knowledge, we find some improvement in knowledge in crop and livestock between 2014 and 2015, in particular in the "good" category. Interestingly, it contradicts to the technical knowledge (Table 4.1) where the knowledge in livestock of the farmers were found better than in crop, the self-assessed knowledge in livestock seems to be weaker than in crop production. This mismatch between what farmers actually know and what they think they know might influence the quality of decision making and their performance in agriculture.

Table 4.2: Distribution of subjective knowledge in crops, livestock and business

Year	2014			2015		
Scale/Knowledge Area	Crop	Livestock	Business	Crop	Livestock	Business
Very Good	7	5	7	4	6	7
Good	86	74	131	147	104	97
Moderate	379	377	345	381	385	306
Low	68	84	72	52	73	88
Very Low	42	42	27	26	43	113
Number of respondents	582	582	582	610	611	611

Note: scale is measured by self-assessed five point Likert scale.

Source: Special surveys in 2014 and 2015, own calculations

4.3.2.3 Management capacity

To measure decision-making ability in both crops and livestock, we confronted farmers with a management choice in crop and livestock respectively (see Appendix B). Two scores were assigned if they could make the correct choice and give a reason that was based on economic logic; one score if respondents were able to make the correct choice but could not give an economically justifiable reason and they received a zero score if the choice was wrong.

The results of the decision-making capacity test are reported in Table 4.3. Farmers seem to make better decision in livestock production than in crop production that is indicated by the larger number of farmers who made wrong decisions that deviated from the profit-maximizing opportunity. In both years 2014 and 2015, the tests show that not many farmers who made the best decisions to maximize their profit provided an explanation for the decision (score 3). Among the farmers who had a correct choice for the best option, many of them failed to give an economic logic for their decisions (score 1). In addition, more or less haft of the farmers made wrong decisions in both crop and livestock production.

Table 4.3: Decision making capacity in crops and livestock

Year	2014		2015	
Score/Area	Crop (%)	Livestock (%)	Crop (%)	Livestock (%)
2 (Correct with economic logic)	12.9	14.9	1.9	9.8
1 (Correct, no economic logic)	38.8	44.0	34.9	44.0
0 (Wrong)	48.3	41.1	63.2	46.2

Note: score is calculated based on the precision of the answer and the reason that farmer reported.

Source: Special surveys in 2014 and 2015, own calculations

To apply the skills in daily decision-making, confidence and cognitive enhance the precision and potential benefits of decision-making. Finally, we applied a set of six cognitive skills questions, which were based on simple calculus and the general ability for logical thinking (Appendix B). The results of the cognitive skills test are reported in table 4.4. Most farmers obtained moderate scores of 3, 4 or 5, while only few farmers have the highest score of 6 in the test. There are also farmers who got extremely low score from the test with no or just one correct answer to the six questions. This low cognitive skill should weaken their ability to make good management decisions and to justify logically. To sum up, farmers seem to have moderate cognitive skill and justification; similarly they have moderate capacity of making-decision. However, there are not many farmers who have strong cognitive skills or strong ability to apply knowledge in decision-making.

Table 4.4: Cognitive skills scores of Hue farmers in 2014 and 2015

Score/Year	2014	2015
6	68	51
5	152	102
4	212	176
3	125	178
2	44	67
1	23	42
0	1	4
Number of respondents	622	620

Source: Special surveys in 2014 and 2015, own calculations

Besides observing farmers making decisions in the decision games, we ask farmers how confident they are when they face with decisions in different aspects of daily farming activities. The farmers self-reported their confidence by choosing a level on a five point Likert scale ranging from "always confident" to "never confident". The outcomes of this question are summarized below, separately for the survey in 2014 and the survey in 2015.

Table 4.5: Confidence in decision making in agricultural activities

Score/Year	2014	2015
Always	327	247
Mostly	145	222
Sometimes	71	97
Mostly not	35	37
Never	2	8
Number of respondents	580	611

Source: Special surveys in 2014 and 2015, own calculations

The results show surprisingly that almost two third of the respondents reported that they are always or mostly confident in making decisions, similarly in both two surveys. Only some respondents reported that they have no confidence in decision-making. That is also interesting to relate to the knowledge score tests and the performance in decision games. In the tests or games, the majority of the respondents performed below the highest scores.

4.3.2.4 Extension services

External support is important for farmers who have low education and limited access to technology. To know about this source of support for the farmers in our research sample, we added questions in regards to the frequency of extension visits separately for crop and

livestock as well as farmers' participation (or other household members) in agricultural training programs.

We can see from the Figure 4.4A, 4.4B and 4.4C that only less than half of the households received support from extension services in terms of visits and trainings, both in crop and in livestock production. Nevertheless, there is some improvement in providing support from the extension services in 2015 in comparison with that in 2014 that is presented by a considerably higher number of households who have contacts, albeit with relatively low frequency.

Only 50 households among above 600 households received extension services in 2014 and 150 households among them received in 2015. Among households who received extension services, most households got with low frequency such as once per year or once per six months. That applies for the extension services provided to both crop and livestock production.
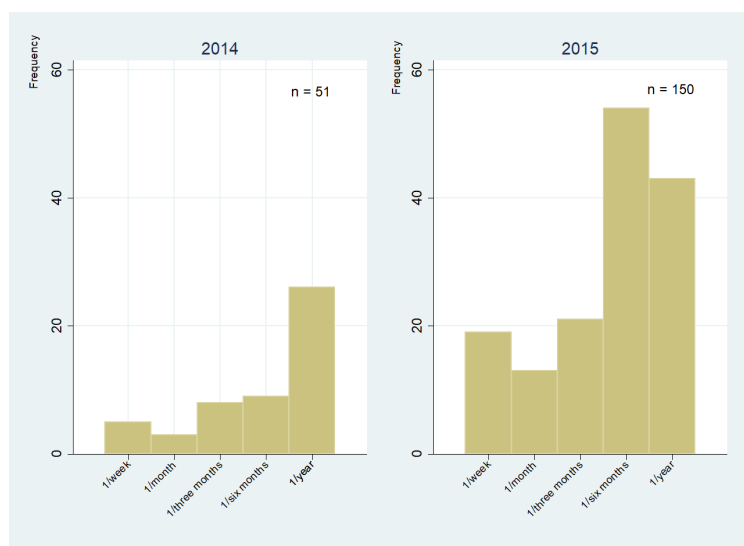
Figure 4.4A: Frequency of receiving crop extension services

Note: frequency is measured by the time(s) that household received the services

Source: Special surveys in 2014 and 2015, own calculations

In 2014 only one fifth of the households received extension services in livestock production and in 2015 that number increased to about one third. However, most of those households received the services only every three months, six months or one year. With this low frequency, the effectiveness of extension services could not be guaranteed.
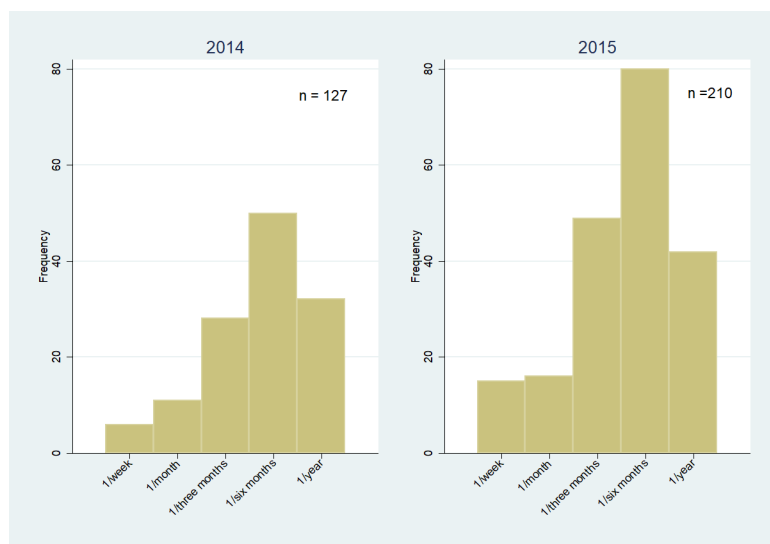
Figure 4.4B: Frequency of receiving livestock extension services

Note: frequency is measured by the time(s) that household received the services

Source: Special surveys in 2014 and 2015, own calculations

More than half of the households did not attend in agricultural trainings in both years: about 100 household in 2014 and less than 300 households in 2015. Compared with the number of households who have members participating in agricultural trainings the number of households increased in 2015.
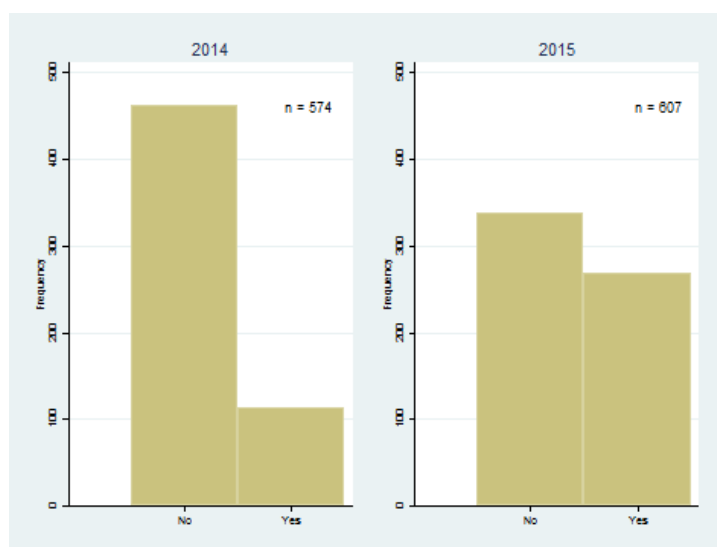
Figure 4.4C: Household members participated in training

Note: yes if farmer of other members of his household participated in training in agricultural production

Source: Special surveys in 2014 and 2015, own calculations

In summary, our 2014 and 2015 surveys contained a wealth of information that can give a good indication of the capabilities of Vietnamese farmers concerning knowledge, skills and confidence in making decisions in crop as well as external support in agricultural production. The results show that most farmers have relatively low knowledge both in tested and self-

assessed measures. Farmers received limited support from agricultural extension in terms of visits or trainings. The results of decision-making tests show that about half of the farmers deviated from the optimal choice in decision-making to maximize their benefits that was shown in the decision-making games, both in crop and livestock production.

4.3.2.5 Farming performance

To assess the performance of the farmers, data including seven comprehensive household surveys conducted from 2007 to 2013 were combined with the special surveys in 2014 and 2015. From each survey wave, the information on crop yield and livestock production as well as relevant costs was collected. Based on the data, rice is found to be the main crop of the farmers in the sample. There are somewhat fewer observations in our sample for cassava and maize. For livestock, two production enterprises are common in Hue, namely pig fattening and piglet production. While most farms who have chicken and ducks, majority of them are non-commercial and small-scale with the purpose for home consumption. Hence, we did not include these enterprises in the farm performance analysis.

Finally, we have seven time point panel data of crop production and four time point panel data of livestock production[8]. In Table 4.6, we report the results of the average yield in kilograms per hectare and the standard deviation for summer and winter rice, cassava and maize during the period from 2007 to 2015. The average number of piglets per sow per year and the gross margin for pig fattening are calculated. In the absence of meaningful biological productivity measures, those indicators are used as proxies of the productivity of livestock production.

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[8]Questions on costs of livestock production were excluded in some surveys therefore there is not enough information to calculate the gross margin of livestock.

Table 4.6: Productivity of crop and livestock over time

Year	Winter Rice	Summer Rice	Cassava	Maize	Piglets/sow/year	Gross margin/Pig Fattening (USD-PPP)
2007	3819	3540	8767	3989	N.a	N.a
2008	4026	3704	11559	4151	14.38	33.72
2010	4042	3707	10866	4522	9.63	28.97
2011	3874	3419	11030	3602	10.57	46.70
2013	4108	3867	12296	3201	14.61	25.35
2014	3669	3017	12878	2965	N.a	N.a
2015	4399	4050	13458	4029	N.a	N.a
Mean	3994	3614.86	11550.57	3779.86	12.29	32.69
Standard Deviation	234.85	334.36	1551.56	551.52	2.57	9.33

Note: N.a.: not available; in 2014 and 2015 surveys no livestock balance sheets were elaborated. USD-PPP: US Dollar Purchasing Power Parity.

Source: TVSEP survey from 2007 to 2013, special surveys in 2014 and 2015, own calculations

Except the rather low yield in 2007, the yields of rice remained stable across the years since 2008. However, the cassava yield changed relatively across the years, whereas maize yield was low in 2014 in comparison with other years. On average, all crop yields got positive growth rate during the time from 2007 to 2015. In contrast to that crop yield is relatively stable, livestock production changed considerably from year to year. The productivity of sows measured by the number of piglets that a sow produced per year was low in 2010 and in 2011 while it was higher in 2008 and 2013. Similarly, the trend of pig fattening productivity that is proxied by the gross margin in US Dollar purchasing power parity per pig fattening is fluctuated over the years.

To conclude, farmers' livestock production shows stronger fluctuation over time in comparison with crop productivity. That implies livestock production relates to relative more risk and requires farmers' better technical knowledge. In Figure 4.5, we show a bar chart that displays the average annual growth rate in the productivity of crop yields and livestock production between 2007 and 2015. Due to strong fluctuation of the gross margin of pig fattening, the average growth is extremely low at roughly 0.5%. Therefore, this indicator is excluded from the figure to avoid a highly skewed presentation.
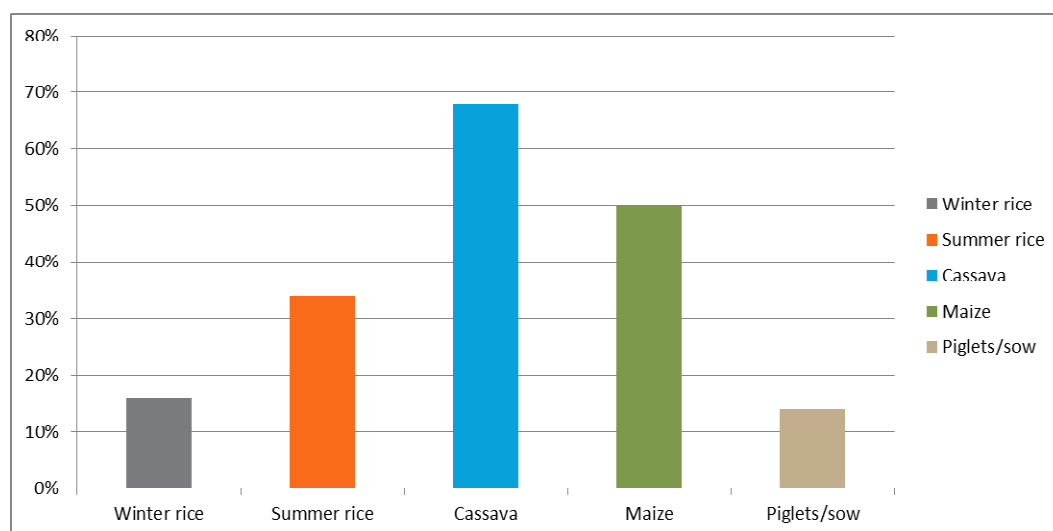
Figure 4.5: Average annual growth rate of the productivity of crop and livestock production

Note: Growth rate is calculated for only households who had production over the years
Source: TVSEP survey from 2007 to 2013, own calculations

Regarding the average annual growth of crops, the results show a positive trend in both summer and winter rice yield, while both cassava and maize have a high variation over time. Similarly, the measures of livestock growth indicates on average livestock production is increasing over time, albeit slightly. In addition, the livestock production measured by the number of piglets per sow per year and gross margin of pig fattening as shown in Table 4.6 is prone to strong variation over time.

4.4 Bivariate analysis

This section presents the pairwise approach to analyze the relations among the indicators of knowledge and skills as well as the parameters of agricultural productivity. First, the relations among risk attitudes, knowledge and skills in decision-making and in cognitive are reported. Second, the test of relationship between farm productivity and relevant variables are conducted.

4.4.1 Knowledge, decision-making ability, cognitive skill and risk attitudes

To investigate the relations between risk attitudes, knowledge and skills of the farmers, Table 4.7 presents the outcomes of Chi square test applied pairwise on those variables. The variables of knowledge are grouped based on the distribution in Table 4.1. Cognitive skills are grouped into three groups according to the similarity of the skill level such as group one has the test scores lower or equal to 2. Group two has scores in between 3 and 5 and group three has highest scores of 6 correct answers to total six questions. Similarly, the willingness to take risks are grouped by the ascending order into low (lower than 5), middle (from 5 to 7) and

high (from 8 to 10). The variable of subjective knowledge in doing business is scaled into three groups: group one for low, group two for middle and group three for the strongest degree of subjective knowledge on the five point Likert scale.

Although the correlation coefficients are not perfectly consistent between the outcomes in 2014 and in 2015, stronger farmers' knowledge in livestock remains significantly correlated with the increase in their willingness to take risks. Similarly, we find a statistic significant correlation between management ability (decision-making ability) and risk-taking, albeit weaker in 2015. There is a significant relation between cognitive skill and risk attitudes although the connection is not strong. Interestingly, the relation between the willingness to take risks and subjective knowledge in doing business is strongly significant. That finding is consistent across the year from 2014 to 2015.

Table 4.7: Risk attitudes and farmers' knowledge and skills

Year	2014			2015		
Chi Square Test	Pearson chi2(4)	Prob.	N	Pearson chi2(4)	Prob.	N
Willingness to take risks (WTR)						
Crop knowledge	3.50		500	3.59		489
Livestock knowledge	9.09	*	460	10.86	**	471
Crop decision	6.46		480	6.13		473
Livestock decision	12.97	***	450	7.81	*	461
Subjective knowledge in doing business	25.11	***	520	36.15	***	560
Cognitive skills	8.48	*	561	6.49	*	568

Note: Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$
Source: Special surveys in 2014 and 2015, own calculations

There is no significant relation between farmers' knowledge in crop and risk attitudes. Likewise, the relation between decision-making ability in crop production has no significant correlation with risk attitudes. Differently, both knowledge in livestock production and decision-making in livestock have significant association with the willingness to take risks, albeit the significance level slightly changes across the years.

4.4.2 Farmers' knowledge, kills and farm productivity

Following our expectation that farmers who have higher knowledge and skills are more likely to achieve better performance of their crop and livestock enterprises, we apply ANOVA (Analysis of Variance) using F-test to investigate the significance of productivity differences

by knowledge and skills scores. Farm productivity is measured by summer and winter rice yield, piglets per sow per year and gross margin of pig fattening.

In the results of Table 4.8, we do not find consistent significant difference in productivity across groups of farmers by technical knowledge and decision-making skill. In particular, both test scores of technical knowledge and management decision skill are unlikely significantly correlated with productivity parameters, either in crop or in livestock production. Nevertheless, the technical knowledge has a slightly significant correlation with livestock production and the management decision skill is significantly correlated with crop productivity, albeit relatively weak.

Table 4.8: Farmers' knowledge and skills and farm productivity

Year	2014			2015		
ANOVA Results/No of observations (N)	F-value	Prob.	N	F-value	Prob.	N
Technical knowledge						
Winter Rice Yield	1.28		298	0.22		302
Summer Rice Yield	1.8		267	1.22		265
Piglet Production	1.1		94	2.50	*	104
Pig Fattening	2.45	*	111	4.12	**	131
Management (decision-making) ability						
Winter Rice Yield	2.31	*	288	1.42		291
Summer Rice Yield	3.95	**	256	0.11		258
Piglet Production	0.49		92	0.67		103
Pig Fattening	0.78		95	2.50	*	131

Note: ANOVA test (Analysis of Variance test). Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.
Source: TVSEP survey from 2007 to 2013 and special surveys in 2014 and 2015, own calculations

Some inconsistency in the results probably implies uncertainty of farmers' knowledge and the practiced skills in decision-making. That could be also resulted simultaneously from their low self-confidence and risk aversions when facing with tests and decision-making.

Table 4.9 summarizes the test outcomes on the relation between farm productivity and farmers' subjective knowledge and self-confidence in decision-making in agriculture. Subjective knowledge shows a stronger correlation with both crop and livestock performance in comparison with the test scores of technical knowledge (Table 4.8). In particular, subjective knowledge of farmers has positive association with crop productivity that is statistically significant and somewhat consistent in both two years.

Table 4.9: Farmers' subjective knowledge, self-confidence and farm productivity

Year	2014			2015		
ANOVA Results/No of observations (N)	F-value	Prob.	N	F-value	Prob.	N
Subjective knowledge						
Winter Rice Yield	6.98	***	301	2.66	**	317
Summer Rice Yield	3.31	***	270	2.02	*	278
Piglet Production	1.70		97	3.08	**	107
Pig Fattening	1.84		117	4.08	***	138
Self-confidence in decision-making						
Winter Rice Yield	1.52		301	2.57	**	317
Summer Rice Yield	0.85		270	2.29	*	278
Piglet Production	0.07		97	2.06		107
Pig Fattening	1.92		117	1.84		138

Note: ANOVA test (Analysis of Variance test). Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.
Source: TVSEP survey from 2007 to 2013 and special surveys in 2014 and 2015, own calculations

The self-confidence in decision-making of the farmers is unlikely correlated with their performance in livestock production. There are some weakly significant and positive correlations found between rice productivity and farmers' confidence in decision-making, albeit relatively weak. One can doubt the association between farmers' self-confidence and their real performance, probably also their real practice in decision-making.

Table 4.10 presents the test results on the relationship between agricultural productivity and farmers' cognitive skills and willingness to take risks. Interestingly, similar to the subjective knowledge, cognitive skill has a positive relationship with crop productivity. The finding is statistically significant at 1% and consistent across the surveys. In contrast, there is no significant correlation is found between cognitive skills and livestock productivity.

In respect of the relation between risk attitudes and agricultural productivity, little is statistically significant found. As suggested by relevant literature, risk-taking is a crucial element in decision-making such as to adopt technology in agriculture, it is expected that farmers' willingness to take risks to be positively correlated with farm productivity. Nevertheless, the results reported in Table 4.10 do not submit to this expectation. One might expect there is an indirect association between them such as risk attitudes influence knowledge and learning technology, consequently it has impact on the agricultural performance. However, if farmers' knowledge does not reflect their learning and technology adoption, the link between risk-taking and performance can be disturbed.

Table 4.10: Farmers' cognitive skills, risk attitudes and farm productivity

Year	2014			2015		
ANOVA Results/No of observations (N)	F-value	Prob.	N	F-value	Prob.	N
Cognitive skills						
Winter Rice Yield	6.51	***	308	9.90	***	317
Summer Rice Yield	7.15	***	273	8.68	***	278
Piglet Production	0.85		99	0.70		107
Pig Fattening	0.24		119	2.17		138
Willingness to take risks						
Winter Rice Yield	0.56		307	0.23		317
Summer Rice Yield	0.92		272	0.21		278
Piglet Production	3.73	**	99	0.91		99
Pig Fattening	0.74		118	0.05		138

Note: ANOVA test (Analysis of Variance test). Significance levels: * $p<0.1$, ** $p<0.05$, *** $p<0.01$.
Source: TVSEP survey from 2007 to 2013 and special surveys in 2014 and 2015, own calculations

4.5 Conclusion

The researched farmers are found to have low knowledge in crop and livestock production in terms of both test scores and own self-assessment. The farmers are not confident in decision-making and perform poorly in decision-making tasks. They tend to have economic logic for their decisions. At the same time, they are more likely to be risk-averse and to have low cognitive skills. Additionally, not many of them received necessary external support regarding technology and training from official institutions. Consequently, their agricultural performance tends to be reliant on their subjective knowledge rather than on the technical knowledge. The overall results indicate that the agricultural productivity among the farmers who achieved limited knowledge and technology are less skillful in decision-making. The risk-averse farmers can be more dependent on external factors, such as external support from extension services. Therefore, further objective-oriented external support is recommended. Similarly, those farmers could be more vulnerable to shocks and have lower capacity to cope with shocks. Furthermore, the financial and human resources that are required in agricultural inputs is suggested to also play a role in agricultural productivity. With low level of knowledge and ability, farmers' evaluation can be less precise and their decisions can be more fluctuated, consequently leading to poor performance. Therefore, further studies could investigate the multivariate analysis on the crucial factors as stated in abovementioned assumptions to improve the extension services, to enhance farmers' knowledge and management capacity and finally to improve agricultural productivity.

CHAPTER 5

CONCLUSIONS

This chapter summarizes the studies that comprise this thesis. It provides the major conclusions and suggests ideas for further research.

5.1 Summary

The major objective of the thesis is to evaluate the measurement of risk attitudes that is consequently used it to assess the role of risk attitudes in economic outcomes among a rural population. In particular, it aims (i) to validate the survey question to measure the individual general willingness to take risks, (ii) to explore the ethnic heterogeneities of risk attitudes and economic welfare and to assess the linkage between risk attitudes and economic welfare in presence of the ethnic diversity and (iii) to investigate the role of risk attitudes and knowledge in agricultural performance. The main part of the data used in this thesis is sourced from a long socio-economic panel (TVSEP, www.tvsep.de) that has been implemented in six provinces in Thailand and Vietnam since 2007. In addition, we use the data collected by a risk-focused survey with the sample of Hue province in 2015 that provides measurement of farmers' knowledge, risk attitudes, confidence and decision-making in agriculture.

This thesis measures risk attitudes among a culturally diverse population to test whether this simple question can be validated by a risk experiment. Furthermore, it examines the power of the survey-based risk attitudes to predict the risky behaviors within and across ethnic groups. For the second chapter, 679 households from Dak Lak province of Vietnam serve as research sample. The decision makers of the households completed in a survey before being invited to participate in a risk experiment. In the analysis, we test the experimental validity of the survey-based general risk attitudes among a culturally diverse population of rural households in Vietnam. Multivariate correlation analysis is applied with different regression models to investigate the correlation of risk attitudes with individual and household characteristics. We separately examine this correlation between the survey-based measure and the experimental outcomes for the ethnic majority group and the group of the ethnic minorities.

Based on the validity of the survey question to measure the general risk attitudes of the household decision maker, the thesis investigates the relationship between risk attitudes and economic welfare. In particular, it explores the role of cultural factors shaped by different ethnicities in risk attitudes, thereby influencing economic behaviors and economic outcomes.

A three-wave balanced data set that is used as research sample includes almost 600 ethnically diverse households from both Dak Lak and Hue provinces in Central Vietnam By intentionally choosing those provinces that represent the ethnically diverse populations, the study investigates the ethnic dimension of the relationship between risk attitudes and economic welfare. This research extends the literature that investigates the linkage between risk attitudes and economic welfare by using different approach. It assumes that risk attitudes is driven by cultural factors that vary across ethnic groups and socioeconomic backgrounds, therefore, cultural factors could also lead to complex patterns of the relationship between risk attitudes and economic welfare. The single-equation approach employs a fixed effects model and a correlated random effect model, namely the Hausman-Taylor model to explore determinants of economic welfare including risk attitudes. To test a mutual relationship between risk attitude and economic welfare, a system-equation approach using the Three Stage Least Squares regression is applied. Ethnic disaggregating enables to compare across ethnic groups.

Knowledge encourages risk-taking behaviors since it reduces the uncertainty in decision environment to strengthen risk tolerance of the decision makers. In addition, knowledge can also enhance the ability to understand the information that supports decision-making and consequently the performance of farmers. However, lack of education and little access to information, poor farmers tend to apply their subjective knowledge and heuristics in decision-making instead. To comprehend the mechanism in which risk attitude relates to farmers' skills, knowledge and productivity, chapter 4 researches on the relations between risk attitudes, knowledge, management decision capacity and agricultural performance. A special survey was used to collect data on risk attitudes, knowledge and management decision capacity in 2014 and in 2015. The indicators of the farming productivity in cop and livestock production were calculated based on the past performance of the households by using data from the long-term household survey from 2007 to 2015. To achieve the objectives of this study, a deep descriptive analysis using non-parametric tests is applied. Chi square tests are used to explore the relations between risk attitudes, knowledge and decision-making capacity of the farmers. One-way Analysis of Variance (ANOVA) using F-test method is applied to test the relationships between the indicators of agricultural performance and farmers' knowledge, risk attitudes and skills. In sum, the analysis enriches the understanding of the variation in farmers' abilities and agricultural performance across a diverse population in rural areas of Vietnam.

5.2 Main findings and future study

This thesis confirms the effectiveness of a survey question to measure the individual risk attitudes. Especially, the usefulness of a survey question is tested by measuring the individual willingness to take risks among the largely heterogeneous subjects. The consistency of the risk attitudes measured by a survey question is documented by predicting the outcomes of a risk experiment and its important predictors among individual characteristics and household characteristics. Furthermore, the results submit that a survey-based measure is a valid instrument to predict risk behaviors among a culturally diverse population. This survey-based measure widens the scope for empirical researches that rest on large-scale panel data. In particular, our findings suggest that the survey-based measure can be applied among culturally diverse communities as well as among the people who have low official education and are more attached to their own traditions that are often thought to be deviating from the assumption of *homo economicus*.

The survey-based measure of the willingness to take risks is used to investigate the relationship between risk attitudes and economic welfare among an ethnically diverse sample. Specifically, that sample includes the ethnic majority who is socio-culturally homogenous and the group of various ethnic minorities who own different cultural values. The results indicate significant differences in both the willingness to take risks and economic welfare between two ethnic groups. Particularly, the ethnic minorities expressed higher degree of risk aversion meanwhile they are economically worse-off in comparison with the ethnic majority. In addition, different determinants of economic welfare and the individual willingness to take risks are found between the ethnic majority and the minorities. For instance, the willingness to take risk of the ethnic minorities tends to be more vulnerable to shocks.

Analyzing the relationship between risk attitudes and economic welfare by various approaches demonstrates the divergence between two ethnic groups. First of all, a positive and linear association between risk-taking and economic wellbeing presents apparently among the socio-culturally homogenous ethnic majority. In contrast, economic welfare is not a monotonic function of risk taking among the group of ethnic minorities. The association between risk aversion and economic welfare is negative at the strongest level of risk aversion. However, the coefficient of this correlation is not constant; the magnitude of that negative correlation is gradually decreasing in the increasing risk-taking and turns to be positive after a certain threshold. To sum up, the results indicate that cultural factors drive those complex patterns of that relationship among an ethnically diverse population. Future studies could

invest in the interaction between risk attitudes and social behaviors within and across ethnic groups. The results of those potential studies could shed light on the mechanism in which culture influences economic development and poverty to challenge the preserved stigmatization of culture of poverty that explains culture causes poverty because the poor people have deficient values and behaviors. Another suggestion for future research is the potential evidence of a dynamic relationship between risk attitudes and economic welfare on condition of long panel data. Results of this potential study could explain convincingly the role of risk aversion in vicious circle of poverty and the role of risk-taking as a catalyst of economic development in long term.

Results of the fourth chapter deliver crucial insights into understanding farmers' practices and productivity. In the first place, a large variation is found in knowledge among farmers in respect of both technical and subjective measures. Most farmers have low knowledge in crop and livestock production in terms of both test scores and own self-assessment. They performed poorly in decision-making games by deviating from the profit-maximizing profit option and by failing to have an economic logic for their decisions. At the same time, most of them tend to be considerably risk-averse and have low cognitive skills. Unfortunately, not many of them received necessary external support regarding agricultural extension visits and trainings from official institutions. Consequently, their agricultural performance tends to be more reliant on their subjective (i.e. experiential) knowledge rather than the technical knowledge. Further studies need to investigate the determinants of agricultural productivity in a multivariate analysis and in a dynamic perspective. Particularly, the role of risk attitudes through a relationship with knowledge in farm productivity should be of interest in future research.

The methodological contribution of this dissertation is twofold; firstly, it widens the usefulness of the survey-based measure towards individual risk attitudes, particularly to be applied among a strongly diverse population. It also suggests a mixed method strategy in combination with experimental instruments to observe the individual risk attitudes most effectively. Secondly, it suggests a multi-method approach that is needed to understand the relationship between risk attitudes and economic welfare among a diverse population, provided that, the socioeconomic and cultural factors could drive this relationship in different ways. Additionally, rich survey data in combination with experimental data are ideal to pursue the above-mentioned approach. Further research could invest in the mechanism in which education, risk attitudes and cultural factors are related would be a potential contribution to the relevant literature. Similarly, future studies could investigate some direct evidence of the

relationship between risk attitudes and the intensification of the cooperation across cultural groups to understand the role of cultural diversity in economic development and poverty. That will trigger the positive effect of cultural diversity on economic development and poverty reduction among poor populations. A dynamic model could be applied in future research that is suggested by the appropriation of a simultaneous equations model under an assumption of correlated error terms that was applied in this thesis.

5.3 Policy implications

The findings delivered by this dissertation submit important implications to policy-making, especially that targets poverty and inequality simultaneously, particularly among socio-culturally diverse populations.

Firstly, the usefulness of the survey-based risk attitudes is suggested to find a missing piece in understanding of decision-making and outcomes that are needed for effective policies. It is principally crucial when those policies are to apply on a large population in presence of social and cultural diversity. In the light of the results of a strong association between the survey item and the risk experiment in capturing risk attitudes among the ethnic minorities, the assumption of a "self-reinforcing culture of poverty" which is often attributed to minority group of Vietnam should be challenged. Economic policies should not be solely made without involvement of social and cultural analyses that include risk perceptions and behaviors.

Secondly, the ethnic heterogeneity of risk attitudes and economic welfare suggests a need to consider ethnic heterogeneity into the economic interventions among the poor. The difference in the willingness to take risks across ethnic groups is suggested to social protection policies that target different social or cultural groups who are characterized by different attitudes and behaviors. Based on the willingness to take risks and socio-demographic and cultural background, policies should offer different treatments tailored to specific capacity to cope with risks.

Thirdly, interventions to stimulate economic development via improving knowledge and encouraging risk-taking activities need to be considered as necessary for poverty alleviation policies in such ethnically diverse populations. Particularly, interventions should be not only technical support but also education and facility that suit to specific needs and capacity to improve risk tolerance and confidence.

Finally, policy-making should take into account the interrelation between risk attitudes and extension services towards farmers to enhance the role of risk attitudes and knowledge in technology adoption and agricultural development. Similarly, evidence of the relation between of knowledge, risk attitudes and confidence in farmers' decision-making is essential to improve the agricultural extension systems. To sum up, this thesis introduces a new approach towards poverty and inequality that is suggested to be through a risk channel. It provides the first evidence of the interaction between risk attitudes and economic welfare that is driven by cultural factors.

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APPENDICES

APPENDIX A

Table A1: Descriptive statistics

Variable	2008 Mean	2008 SD	2010 Mean	2010 SD	2013 Mean	2013 SD
Economic welfare						
Consumption [a] (PPP USD)	4.93	3.75	4.71	3.35	6.14	4.34
Income[b] (PPP USD)	5.24	7.70	4.11	4.90	5.36	6.95
Wealth[c] (PPP USD)	687.60	1044.41	641.45	1007.08	1044.66	2293.04
Individual characteristics						
WTRg	3.39	3.20	4.14	2.83	5.58	2.57
Age (years)	45.67	12.36	47.67	12.36	50.67	12.36
Female (%)	40					
Ethnic majority (%)	70					
Married (%)	85					
Self – employed (%)	16	37	18	38	20	40
No religion (%)	78					
Health impairment (%)	18	38	22	41	29	46
Optimism[f]	0.45	0.64	0.43	0.64	0.41	0.67
Membership[d] (%)	67	47	65	48	67	47
Education (years)	5.82					
Household characteristics						
Household size[e]	4.50	1.89	4.39	1.77	4.10	1.75
Household dependency ratio	0.37	0.25	0.37	0.30	0.39	0.38
Non-farm land (ha)	0.69	1.65	0.80	2.52	0.57	2.77
Crop land (ha)	0.35	0.57	0.31	0.50	0.45	2.58
Member average age (years)	31.03	13.67	32.80	13.59	36.47	14.67
Member average edu. (years)	6.49	4.84	5.83	2.80	6.42	3.00
Migrating members[e]	0.24	0.67	0.36	0.79	0.21	0.63
Literate members[e]	3.82	2.00	4.19	2.01	3.88	1.72
Self-employed members[e]	0.36	0.66	0.45	0.75	0.44	0.74
Shocks						
Economic shocks[e]	0.14	0.38	0.38	0.67	0.42	0.65
Agricultural shocks[e]	1.22	0.93	1.22	0.93	0.54	0.62
Socio-demographic shocks[e]	0.50	0.75	0.63	0.80	0.64	0.76
Geographic (village levels) characteristics						
Distance to district town (km)	14.68	11.70	13.69	10.86	12.48	9.39
Water quality (decreasing scale)	3.44	1.38	3.26	1.38	3.22	1.53
Stability (years)	10.26	9.11	10.36	7.79	12.57	10.59
Road quality (decreasing scale)	2.79	0.97	2.93	1.05	2.86	0.91
Coastal	0.18					
Mountainous	0.49					

Notes: [a] Daily consumption per adult equivalent (AE): Organization for Economic Cooperation and Development adult equivalents AE = 1 + 0.7*(adults-1) + 0.5*children.[b] Daily income per capita. [c] Total asset value (wealth) per capita. [d] Be member of a social or political organization. [e] Counted numbers. [f] Scale from -2 to 2. [g] WTR: willingness to take risks. Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations.
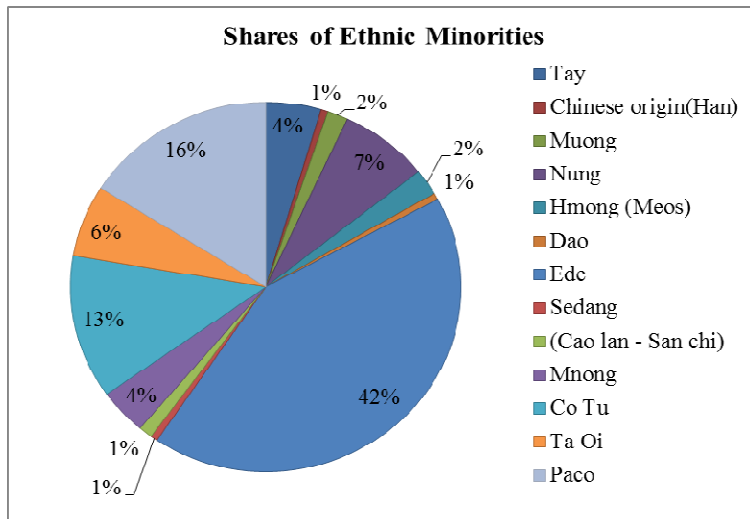
Figure A1: Share of ethnic minorities

Notes: Ede is the largest minority group in Dak Lak and Paco is the largest minority group in Hue.
Source: TVSEP Survey data waves 2008, 2010 and 2013 in Hue and Dak Lak.
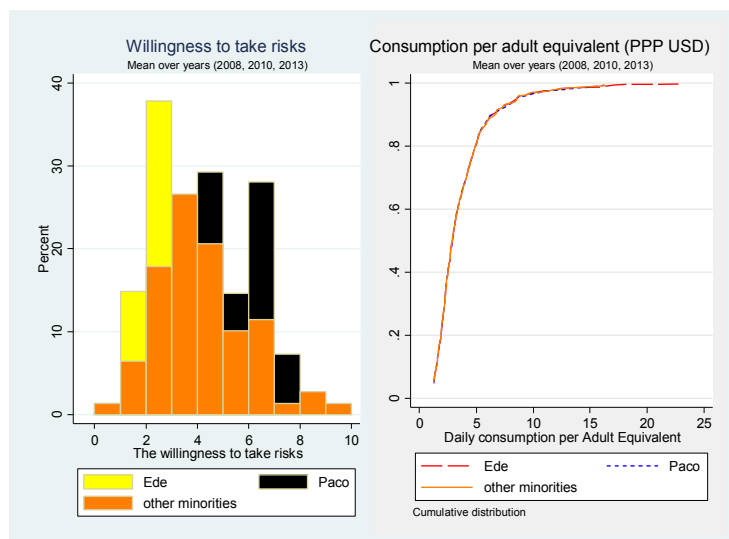
Figure A2: Risk attitudes and economic welfare across ethnic minority groups

Notes: Ede is the largest minority group in Dak Lak and Paco is the largest minority group in Hue.
Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak.

Table A2: Multicollinearity Test

Variable	VIF	1/VIF	Variable	VIF	1/VIF
Age	3.15	0.32	Migrating members	1.31	0.77
Female	1.48	0.68	Literate members	3.54	0.28
Married	1.54	0.65	Self-employed members	2.34	0.43
Majority	1.66	0.6	Coastal	1.58	0.63
Self-employed	2.19	0.46	Mountainous	1.71	0.58
WTR	1.32	0.76	Distance to town	1.08	0.92
Impairment	1.19	0.84	Hue	3.16	0.32
Membership	1.13	0.88	Water quality	1.36	0.74
Education*	1.28	0.78	Eco.shocks	1.08	0.93
Household size	3.49	0.29	Agri.shocks	1.21	0.83
Dependency ratio	1.24	0.81	Demo.shocks	1.07	0.93
Nonfarm land	1.57	0.64	Stability	1.22	0.82
Members' age	3.63	0.28	Road quality	2.45	0.41
Members'education	2.61	0.38			

Note: there is no serious problem of multicollinearity among the variables

Table A3: Tests after the Three Stages Least Squares regression

* Breusch-Pagan LM Diagonal Covariance Matrix Test (3sls)
Ho: Diagonal Disturbance Covariance Matrix (Independent Equations)
Ho: Run OLS - Ha: Run 3SLS
Lagrange Multiplier Test = 249.58454
Degrees of Freedom   =   1.0
P-Value > Chi2(1)   =   0.00000

*Test for Over identification: H0: The system is just identified
Number of equations : 2
Total number of exogenous variables in system : 32
Number of estimated coefficients : 50
Net of 1 linear constraints / dependencies
Hansen-Sargan overidentification statistic :   17.349
Under H0, distributed as Chi-sq(14), pval = 0.2381

* System Heteroscedasticity Tests (3sls)
*** Single Equation Heteroscedasticity Tests:
Ho: Homoscedasticity - Ha: Heteroscedasticity

Eq.		Test:							P				
Eq.	logcon:	Engle LM ARCH	Test:	E2	=	E2_1	=	1.2264	P	Value	>	Chi2(1)	0.268
Eq.	logcon:	Hall-Pagan LM	Test:	E2	=	Yh	=	0.11	P	Value	>	Chi2(1)	0.740
Eq.	logcon:	Hall-Pagan LM	Test:	E2	=	Yh2	=	0.0168	P	Value	>	Chi2(1)	0.897
Eq.	logcon:	Hall-Pagan LM	Test:	E2	=	LYh2	=	0.8469	P	Value	>	Chi2(1)	0.357
Eq.	wtr :	Engle LM ARCH	Test:	E2	=	E2_1	=	0.2958	P	Value	>	Chi2(1)	0.587
Eq.	wtr :	Hall-Pagan LM	Test:	E2	=	Yh	=	2.3559	P	Value	>	Chi2(1)	0.125
Eq.	wtr :	Hall-Pagan LM	Test:	E2	=	Yh2	=	2.0826	P	Value	>	Chi2(1)	0.149
Eq.	wtr :	Hall-Pagan LM	Test:	E2	=	LYh2	=	3.4185	P	Value	>	Chi2(1)	0.065

*** Overall System Heteroscedasticity Tests:
 Ho: No Overall System Heteroscedasticity

Breusch-Pagan LM Test	242.507	P	Value	>	Chi2(1)	0
Likelihood Ratio LR Test	270.965	P	Value	>	Chi2(1)	0
Wald Test	1178.800	P	Value	>	Chi2(1)	0

Table A4: 3SLS estimates of economic welfare and risk attitudes, ethnic minorities

Variables	Economic Welfare (1) Coefficients	Std. Err.	WTR (2) Coefficients	Std. Err.
Willingness to take risks (WTR)	0.119	0.089	-	-
Daily consumption per adult equivalent#	-	-	0.642	0.525
Age	-0.017	0.021	0.136*	0.078
Age square	0.0002	0.0002	-0.002*	0.001
Female	-0.112*	0.065	0.299	0.290
Married	0.042	0.100	0.461	0.377
No religion			0.368	0.263
Self-employed	0.037	0.194	0.519	0.551
Health impairment	-0.124**	0.063	-0.028	0.286
Member of a social or political org.	-0.045	0.059	0.229	0.253
Education[a]	0.151**	0.075	0.038	0.032
Household size	-0.066***	0.021	0.026	0.075
Dependency ratio	0.222*	0.122	-0.007	0.549
Optimistic about future wellbeing			0.302*	0.160
Nonfarm land (log of value)	0.009**	0.004		
Average age of members	0.0007	0.0028		
Average education of members	0.057***	0.011		
Migrating members	-0.013	0.115		
Literate members	-0.0061	0.0203		
Self-employed members[b]	0.179*	0.100		
Economic shocks	0.023	0.052	0.290	0.199
Agricultural shocks	-0.044	0.030	0.182	0.123
Socio-demographic shocks	0.066	0.061	-0.473***	0.155
Hue	-0.460***	0.107	1.127***	0.390
Ede	0.103	0.069	-0.141	0.299
Paco	-0.227***	0.088	0.430	0.391
Constant	1.098**	0.435	-2.609	1.808
R^2	0.270		0.303	
Observations	486		486	

Notes: The Three Stage Least Squares estimates (3SLS). #: Log base ten.:[a] (1) & (3): if household decision maker has higher education than high school, (2) & (4): number of schooling years of the household representative. [b]: (1) & (3): number of self-employed members in household, (2) & (4): if the household representative is self-employed. Control for village level characteristics and time effects. Significance levels: * p<0.1, ** p<0.05, *** p<0.01.
Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations.

Table A5: Testing non-linear relationship in simultaneous equation, ethnic minorities

	Minorities Economic welfare coefficients	Std. Err.	WTR coefficients	Std. Err.
Willingness to take risks (WTR)	0.334	0.394		
WTR square	-0.018	0.039		
Daily consumption per adult equivalent#			**2.872***	0.555
Individual characteristics	*yes*		*yes*	
Household characteristics	*yes*		*yes*	
Ede	0.155	0.146	-0.304	0.337
Paco	-0.250**	0.107	0.734*	0.442
R^2	0.121		-0.104	
Observations		486		

Source: TVSEP Survey 2008, 2010 and 2013 in Hue and Dak Lak, own calculations.

APPENDIX B: QUESTIONNAIRE

The following sections are subtracted from the questionnaire that was used for the special survey in 2014 and minor modifications were added to the survey in 2015. For the questionnaire that was used in 2015, we specified the questions on maize production for farmers who grow maize instead of rice and the questions on cattle production for farmers who raise other animals instead of pigs. In the results, nevertheless, we add them together for two variables of knowledge in crop and knowledge in livestock.

Section 7.1: Risk Game 1

Do you prefer to play the 50:50-lottery (Option A) or to obtain a safe amount (Option B)? (Please show the show card to the respondent and ask him row by row which option he prefers. Tick the appropriate cell that corresponds to respondent's choice).

Row	Option A Lottery (1000 VND)	Please tick the option the respondent would prefer		Option B Safe Amount (1000 VND)
		Lottery	Safe amount	
1	200 : 0			0
2	200 : 0			10
3	200 : 0			20
4	200 : 0			30
5	200 : 0			40
6	200 : 0			50
7	200 : 0			60
8	200 : 0			70
9	200 : 0			80
10	200 : 0			90
11	200 : 0			100
12	200 : 0			110
13	200 : 0			120
14	200 : 0			130
15	200 : 0			140
16	200 : 0			150
17	200 : 0			160
18	200 : 0			170
19	200 : 0			180
20	200 : 0			190

5.1 Knowledge and Decision Making in Crop Production
(only if question 1 in Section 4.1 has "Yes" answer, otherwise go to Section 5.2)
5.1.1 Knowledge questions in rice production
1) Land preparation should be done one day before the rice transplanting.
   Correct _____ *01*
   Wrong _____*02*
2) In a 50 kg bag of 16-20-0 fertilizer, there is 50 kg of nitrogen.
   *Correct*_____ *01*
   *Wrong*_____*02*
3) The most important fertilizer for high rice yields is nitrogen.
   *Correct*_____ *01*
   *Wrong*_____ *02*
4) The more fertilizer one can apply the better for the rice yield.
   *Correct*_____ *01*
   *Wrong*_____*02*
5) Transplanting method is good for weed control.
   *Correct*_____ *01*
   *Wrong*_____*02*
6) Land preparation is not important for the water management during the cropping season in rice.
   *Correct*_____ *01*
   *Wrong*_____*02*
7) The more water in the field is always better for growth of rice.
   *Correct*_____ *01*
   *Wrong*_____ *02*
8) All insects in the rice field are pests.
   *Correct*_____ *01*
   *Wrong*_____ *02*
9) The principle to apply pesticides is to spray only when you see the pests.
   *Correct*_____ *01*
   *Wrong*_____ *02*
10) Harvesting methods does not effect on the grain yield.
   *Correct*_____*01*
   *Wrong*_____*02*

Section 5

5.2 Knowledge and Decision Making in Livestock Production
 (only if question 1 in Section 4.2 has "Yes" answer, otherwise go to Section 5.3)
5.2.1 Knowledge questions in pig farming
1)   Pregnant period in pigs is 5 months
Correct _____ *01*
Wrong _____*02*
2)   Growing pigs in a group makes them grow better than if a pig is alone:
Correct _____ *01*
Wrong _____*02*
3)   A sow can give birth only once a year.
Correct _____ *01*
Wrong _____*02*
4)   Foot-and-Mouth is the major disease in pigs.
Correct _____ *01*
Wrong _____*02*
5)   Pigs are prone to sunburn and sun stroke.
Correct _____ *01*
Wrong _____*02*
6)   Antibiotics should be provided to pigs on daily basis.
Correct _____ *01*
Wrong _____*02*
7)   A sow reaches sexual maturity at 2 years of age.
Correct _____ *01*
Wrong _____*02*
8)   Temperature influences the demand of water in pigs.
Correct _____ *01*
Wrong _____*02*
9)   Crossbreeding is the method to improve the immune system in pigs.
Correct _____ *01*
Wrong _____*02*
10) Cassava is more nutritious feed than rice bran for pigs.
Correct _____ *01*
Wrong _____*02*

5.1.2 Decision making in rice production

Crop decision

The Agricultural Extension Center offers to introduce two new rice varieties (variety A and variety B). Variety A has lower input but also lower yield. Variety B has higher input cost but also higher yield. The center gives you the following information about the two varieties. Suppose that you could grow both varieties in your land, which Variety you choose? (You can use a calculator). Please, explain why do you choose that?

Options	Variety A	Variety B
Area	1 Sao	1 Sao
Cost per Sao	300 000 VND	600 000 VND
Yield per Sao (kg)	100 kg	200 kg
Price per kg	15 000 VND	10 000 VND

5.2.2 Decision making in pig farming

Livestock decision

The Agricultural Extension Center offers to introduce two breeds of pigs (Breed A and Breed B). Breed A has lower weight gain but also lower cost. Breed B has higher weight gain but also higher cost. The Center provides you following information about these two breeds. Suppose that you could apply both options, which Breed do you choose? (You can use a calculator). Please, explain why do you choose that?

Options	Breed A	Breed B
Period	3 months	3 months
Cost	150 000 VND	180 000 VND
Weight	40 kg	60 kg
Price per kg	10 000 VND	8 000 VND

5.3 Additional Questions

CROP PRODUCTION	LIVESTOCK PRODUCTION
1 Do you receive advice from agricultural extension worker?	**1 Do you receive advice from local veterinarian?**
Yes_____ _01 (go to question 2 below)	Yes_____01 (go to the question 2 below)
No_____ _02	No_____02
2 How often do they come?	
Code A	Code A
3 On which topics do they give you advice? *More than one answers possible*	
Code B1	Code B2
4 How are you satisfied with the advice you received?	
Code C	Code C
5 What do you do when crops (livestock) get diseases? *More than one answers possible*	
Code D	Code D

Code A
- 1 Once a week
- 2 Once a month
- 3 Every three months
- 4 Every six months
- 5 Once a year
- 90 Others (specific)

Code B1		Code B2	
1	Variety	1	Breeds
2	Fertilizers	2	Feeds
3	Pesticides management	3	Diseases management
4	Land preparation	4	Hygiene
5	Harvesting	5	Time of slaughter/sales
6	Market information	6	Market information
90	Others (specific)	90	Others (specific)

Code C		Code D	
1	Always satisfied	1	Throw away (leave it aside)
2	Mostly satisfied	2	Self-managing
3	Sometimes only	3	Consult the subject matter specialists
4	Mostly not satisfied	4	Consult the agricultural supplies stores
5	Never satisfied	5	Inform the local government
		90	Others (specific)

5.3 Additional Questions

8. How would you rate your knowledge in…
   a. Crop

Code H
1 excellent = 5
2 very good = 4

3 moderate = 3
4 quite low = 2
5 very low = 1
    b.   Livestock

Code H
1 excellent = 5
2 very good = 4
3 moderate = 3
4 quite low = 2
5 very low = 1
    c.   Doing business in agriculture

Code H
1 excellent = 5
2 very good = 4
3 moderate = 3
4 quite low = 2
5 very low = 1

9. Do you feel confident (i.e. you are sure that you always make a good decision) when you make a decision in agriculture (e.g., Choice of variety, planting time, applying fertilizer, spraying pesticides, purchase of livestock, etc.)?

1 always confident
2 mostly confident
3 sometimes confident
4 often not confident
5 never confident

Section 8 -Quiz

1 What is 54+67
Please fill in answer here or tick box to the right!
Do not know _____97
No answer _____98
2 If you have six friends and would like to give each of your friends three sweets, how many sweets do you need?
Do not know _____97
No answer _____98
3 What is 5% of 500?
Do not know _____97
No answer _____98
4 Suppose you want to buy a bag of rice that costs 230 000 VND. You only have one 500 000 VND note. How much change will you get?
Do not know _____97
No answer _____98
5 In a sale, a shop is selling all items at half price. Before the sale a mattress costs 600 000 VND. How much will the mattress cost in the sale?
300 000 VND
900 000 VND
1 200 000 VND
Do not know _____97
No answer _____98
6 A second-hand motorbike dealer is selling a motorbike for 6 Mio VND. This is two thirds of what it costs new.
How much did the motorbike cost new?
4 Mio VND
9 Mio VND
10 Mio VND
12 Mio VND
2400 20
Do not know _____97
No answer _____98