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ORIGINAL RESEARCH

The Role of Savings and Income Diversification in Households' Resilience Strategies: Evidence from Rural Vietnam

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Abstract
Understanding households' resilience-building strategies is vital for the domains of humanitarian assistance, economic development, and poverty reduction, especially in the places where are vulnerable to shocks. In this study, we offer the first trial that takes into account the correlation between households' risk attitude and their resilience-building strategies, namely savings as an absorptive capacity and income diversification as an adaptive capacity. We examine the effects of these resilience strategies on reducing the impacts of shocks and poverty. We use a panel data of 1227 identical households for Vietnam in two waves of the Thailand–Vietnam Socio-Economic Panel project to investigate the above issues. We address the endogenous problems of households' risk attitude, savings, and income diversification. Our results show that more risk-averse households tend to save more and diversify their income portfolios. These precautionary strategies to build up their resilience capacity help prevent them from reducing consumption caused by shocks and from falling into poverty in absolute, relative, and multidimensional measures. We suggest that rural development policies in developing countries should focus on facilitating more income generation and employment opportunities. Furthermore, the development of rural education and infrastructure for information and communication technology should be taken into account of designing poverty reduction programs.

Keywords Panel data · Absorptive capacity · Adaptive capacity · Instrumental variables

JEL Classification C33 · Q00 · Q12

1 Introduction

Resilience is an important research topic in the current context of more frequent and severe shocks such as political conflict, weather events, economic crises, or diseases (Barrett et al., 2021; Bergstrand et al., 2015; Upton et al., 2022). Understanding households' resilience

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strategy in response to this vulnerable context is necessary to the domains of humanitarian assistance, economic development, food security, and poverty reduction. Rural households in developing countries are living under a vulnerable context with a wide range of unexpected shocks such as climatic calamities, agricultural shocks, economic shocks, and health shocks (Klasen & Waibel, 2015). The negative impacts of these shocks are compounded by a dysfunctional insurance market in these countries (Waibel et al., 2020), which make rural households become more risk-averse (Nguyen et al., 2022b; Sagemüller & Mußhoff, 2020) and even push them into poverty (Nguyen et al., 2020b). The risk attitude of rural households may affect the strategies to build up their resilience to prepare for *ex ante* risks and/or to cope with *ex post* shocks. Although there is a need to take into account of risk preferences in resilience studies (Ansah et al., 2019), the current literature lacks of empirical evidence on the correlation between risk attitude and households' resilience strategy.

Households' resilience strategy (the *ex ante* preparation) lays a foundation for their choices for the *ex post* response to shocks. For instance, some popular (*ex ante*) resilience-building strategies include accumulating savings, improving social and human resources, establishing social network, or diversifying agro-portfolio and income (Ansah et al., 2021; Arslan et al., 2018; Birthal & Hazrana, 2019; FAO, 2016). These preparations would later define households' coping strategies against shocks such as using savings, borrowing and requesting for assistance from relatives and friends, extracting more natural resources, and deploying labor (Ansah et al., 2021; Nguyen et al., 2020a). Among these *ex ante* preparations, savings can be considered as an absorptive strategy and diversification of income sources can be considered as an adaptive strategy (Birthal & Hazrana, 2019; D'Errico et al., 2018; FAO, 2016; Salignac et al., 2022; Slijper et al., 2022; Smith & Frankenberger, 2018). Under the vulnerable context and loss aversions, households might make decisions on strategies that have low returns and lead to lesser welfare (Sagemüller & Mußhoff, 2020). There is little evidence on the effectiveness of these *ex ante* preparations against shocks.

While studies on households' shock coping strategies are rich (for example, see Ansah et al., 2021; Nguyen et al., 2020a; Gröger & Zylberberg, 2016), empirical studies on resilience-building strategies and their impacts are scarce. Further, available studies put a heavy emphasis on identifying the determinants of resilience strategies (Birthal & Hazrana, 2019; Jones et al., 2018; Slijper et al., 2022), leaving the examination on the impacts of these strategies against shocks or poverty nearly untouched. Against this background, we aim to address these research problems. We use a panel data from a long-term socio-economic survey to examine (1) the driving factors of households' resilience-building strategy and (2) the impacts of these strategies on mitigating shocks' impacts and reducing poverty. In this study, we focus on Vietnam, an emerging country in Southeast Asian region, to investigate these research issues because of following reasons. First, Vietnam is among the most vulnerable countries to extreme weather events in Southeast Asia in particular and the country also has a dysfunctional insurance market (Nguyen & Nguyen, 2020; Nguyen et al., 2020b; Waibel et al., 2020). In this regard, rural households in Vietnam must rely more on their own resilience strategy to deal with the vulnerable context. Second, this country is among the fastest growing economies in the world, but, a large majority of its population are still relying on agriculture and living in rural areas (Nguyen et al., 2021). Last, in 2014, Vietnam introduced a national program on rural development with massive investment in rural infrastructure (Do & Park, 2019) and recently extended to the period of 2021–2025. The question arises whether the past investment in infrastructure was actually significant for resilience-building strategies of rural households. We examine the role of risk attitude in defining households' resilience strategies to enrich the literature

on households' behavior under uncertainty in rural areas of developing countries. Additionally, our results are expected to shed further light on the impact of resilience strategy against shocks and poverty. These results are believed to provide useful implications for policymakers in developing countries to formulate appropriate response and development programs for improving rural households' resilience.

The remaining parts the study are as follows. Section 2 provides a conceptual framework and literature review. Section 3 describes the data used in this study and its descriptive statistics. Section 4 explains the research method of this study. Section 5 explains and discusses the results. Section 6 consists of conclusion and policy implications.

2 Literature Review

We use the conceptual frameworks for assessing vulnerability and resilience proposed by the Food and Agriculture Organization of the United Nations (2016), Meybeck et al. (2012), and Ansah et al. (2019) that consider resilience as a household's capacity. Under vulnerable contexts, rural households might make decisions on selecting strategies to prevent or mitigate the impacts of shocks and sustain their consumption (Smith & Frankenberger, 2018; Tan et al., 2020; Wineman et al., 2017). We start with the vulnerable context and risk attitude. The link between uncertainty and risk attitude has been well studied in literature. Besides the characteristics of households and their heads, risk preferences could also be influenced by covariate and idiosyncratic shocks (Gloede et al., 2015; Nguyen et al., 2020b; Liebenehm, 2018). Further, the risk attitude of households could be used to explain their behavior under risks and how they make decisions that might result in low-return investments under loss domains (Sagemüller & Mußhoff, 2020).

The vulnerable context affects households' strategies to enhance their resilience capacities in the *ex ante* period to prevent or mitigate the impacts of shocks, and to cope with shocks in the *ex post* period (FAO, 2016; Meybeck et al., 2012). The literature related to the conceptualization of resilience as a capacity has pointed out three different capacities, namely, absorptive capacity, adaptive capacity, and transformative capacity (Béné et al., 2016; Meybeck et al., 2012). In the case of absorptive capacity, the role of savings is vital for households' resilience (Ansah et al., 2019; DeLoach & Smith-Lin, 2018; FAO, 2016; Salignac et al., 2022; Smith & Frankenberger, 2018; Yilma et al., 2014). The vulnerable context in the form of diverse shock types, number of shocks, and duration of shocks might have different effects on households' choice of accumulating savings (Ansah et al., 2021). Households' demographic characteristics such as age and gender of heads also play a role in affecting households' savings accumulation (Paumgarten et al., 2020). The impacts of savings as an *ex ante* preparation are not clear. On the one hand, Panman et al. (2022) showed that households participating in savings groups appeared to recover faster from shocks caused by flood events. In this case, there *ex ante* preparation is effective in helping them mitigate the impacts of shocks. On the other hand, the results from Smith and Frankenberger (2018) pointed out a vague effect of savings on the absorptive capacity of rural households in dealing with food insecurity in the context of floods.

Regarding the adaptive capacity, this capacity allows households to adapt their livelihood strategies to the vulnerable context (Béné et al., 2016; Meuwissen et al., 2019). This adaptive strategy should be effective in mitigating negative impacts of shocks and/or improving household welfare. Agro-portfolios diversification or income diversification have been widely used to reflect the capacity of rural households to make changes in their

farm production or labor distribution (Birthal & Hazrana, 2019; Liu et al., 2020; Meuwissen et al., 2019). The determinants of households' adaptive capacity included demographic characteristics such as age, gender, education of heads, education of household members, and household land (Arslan et al., 2018; Slijper et al., 2022). The effects of diversification as an adaptive capacity on households' *ex post* welfare have been found to have a positive and significant impact on household income and a negative and significant impact on poverty (Arslan et al., 2018). Nevertheless, some studies found mixed or unclear results of the impacts of diversification on household welfare (Nguyen et al., 2022a; Smith & Frankenberger, 2018).

Different from the absorptive and adaptive capacity, the transformative capacity of rural households refers to enabling conditions that stimulate the changes of basic and fundamental structure of households to improve resilience in a longer term (Carpenter et al., 2005; FAO, 2016; Meuwissen et al., 2019). In this case, the transformative capacity relies on the system's characteristics in which rural households and communities are locating. To reflect the transformative capacity of rural households, empirical studies used indicators at village and communities levels such as access to markets, access to public services, and the development of local infrastructure (D'Errico et al., 2018; Smith & Frankenberger, 2018).

Although the conceptual frameworks for assessing resilience are well-developed, empirical studies in this field show some research gaps that are worthy of attention. First, under the uncertainty and the vulnerable context of rural areas, risk attitude might play an important role in determining households' strategies to build their resilience capacity (Ansah et al., 2019), however, the empirical evidence on the correlation between risk attitude and resilience-building strategy is rather scarce. To the best of our knowledge, we are the first to examine this correlation to fill the research gap.

Second, savings accumulation and income diversification are important in the *ex post* coping strategies against shocks of rural households, however, the current literature shows mixed or unclear results of the effects of these resilience strategies on mitigating shock impacts and improving household welfare (Arslan et al., 2018; Nguyen et al, 2022a; Panman et al., 2022; Smith & Frankenberger, 2018). Furthermore, the available evidence might be produced from biased estimations because of some methodological problems. For instance, Haile et al. (2021) investigated the linkages between resilience and multidimensional poverty, but the endogenous aspects of households' resilience capacity was not well addressed. In addition, the authors also included some highly endogenous variables in their model such as the share of non-farm income, savings, and crop commercialization that have been found to be significantly affected by other households' characteristics (Baidoo et al., 2018; Do et al., 2022; Schulte et al., 2022). We address the potential problems of endogeneity in our models and the results are expected to contribute to the literature by investigating the effects of households' savings as an absorptive capacity and income diversification as an adaptive capacity on shocks and poverty.

Last, many quantitative studies related to resilience employed cross-sectional data (Barrett et al., 2021), while households' resilience should be captured in a long-term perspective (Hoddinott, 2014). Studies using cross-sectional data could not take into account of the before-shock preparation and the after-shock effects on, for example, households' welfare. Furthermore, resilience-building strategies might also be affected by households' unobserved characteristics, the use of cross-sectional data might suffer from the problem of endogeneity caused by omission variables. Hence, we examine the effects of resilience using a panel data from a long-term project that can address these data issues. We expect that the findings from this study could not only fill the gaps in empirical studies, but they could also provide useful insight for stimulating adequate policy response to mitigate the

negative impacts of shocks in developing countries where insurance market is flawed and dysfunctional.

3 Data and Descriptive Summaries

3.1 Study Sites and Data

We use the data from the *"Thailand—Vietnam Socio-Economic Panel (TVSEP): Poverty dynamics and sustainable development: A long-term panel project in Thailand and Vietnam"* funded by the German Research Foundation (DFG FOR 756/2). The TVSEP was aimed to provide a better understanding and to establish a panel dataset for studies on livelihood and vulnerability to poverty dynamics in rural areas of developing countries in Southeast Asia (Hardeweg et al., 2013). In Vietnam, the TVSEP has been collecting information from about 2200 households in three provinces, namely Ha Tinh, Thua Thien Hue, and Dak Lak province in the central region of the country (see Fig. 1 for the study sites). The sampling process of the TVSEP data relied on the guidelines on designing household survey samples of the Department of Economic and Social Affairs of the United Nations (2005). This sampling consists of a three-stage stratified random method that based on the administrative system of Vietnam. At the first stage, communes in each province were selected by the weighted share of each commune's population in the district/province (the Vietnam's administrative system flows from provinces/municipalities (highest level) to districts, communes, and villages (lowest level)). At the second stage, villages in each commune were identified by using a probability proportional to the size of villages in commune's population. At the final stage, ten households in each village were randomly selected from a list of all households in the villages with equal probabilities (see Hardeweg et al. (2013); Nguyen et al. (2021) for the detailed explanations of the TVSEP's survey design and data collection).

The household data of the TVSEP were collected from a structured questionnaire using tablets with Computer Assisted Personal Interviewing (CAPI). The household questionnaire includes several modules such as general information (e.g., household member characteristics, expenditure, and assets), livelihood strategies (e.g., land, agriculture and natural extraction, wage-employment, and self-employment), shocks and risks, finance (e.g., borrowing, lending, savings, public transfer, and insurances), character traits, religion, investment and disinvestments. These data were recorded for the past 12 months of the reference period (normally from May of this year to April of the next year). To facilitate a further comparison at international level, the TVSEP data have included not only monetary values in current and local currencies, but also monetary values in international dollars using Purchasing Power Parity (PPP$) adjusted to 2005 prices. In the household survey, the heads of households were often the respondents of interviews. Besides the household data, the TVSEP also collects information of villages where sampled households were living. The village data were collected from a structured village questionnaire and the heads of villages were usually the ones who provided the information. The village questionnaire has a wide range of data such as infrastructure characteristics, institutions, employment, economic and environmental conditions, and agriculture. The household and village variables are described in Appendix 1.

Thus far, in Vietnam, the household surveys of the TVSEP that fully conducted in all three provinces include the waves of 2007, 2008, 2010, 2013, 2016, and 2017. In this

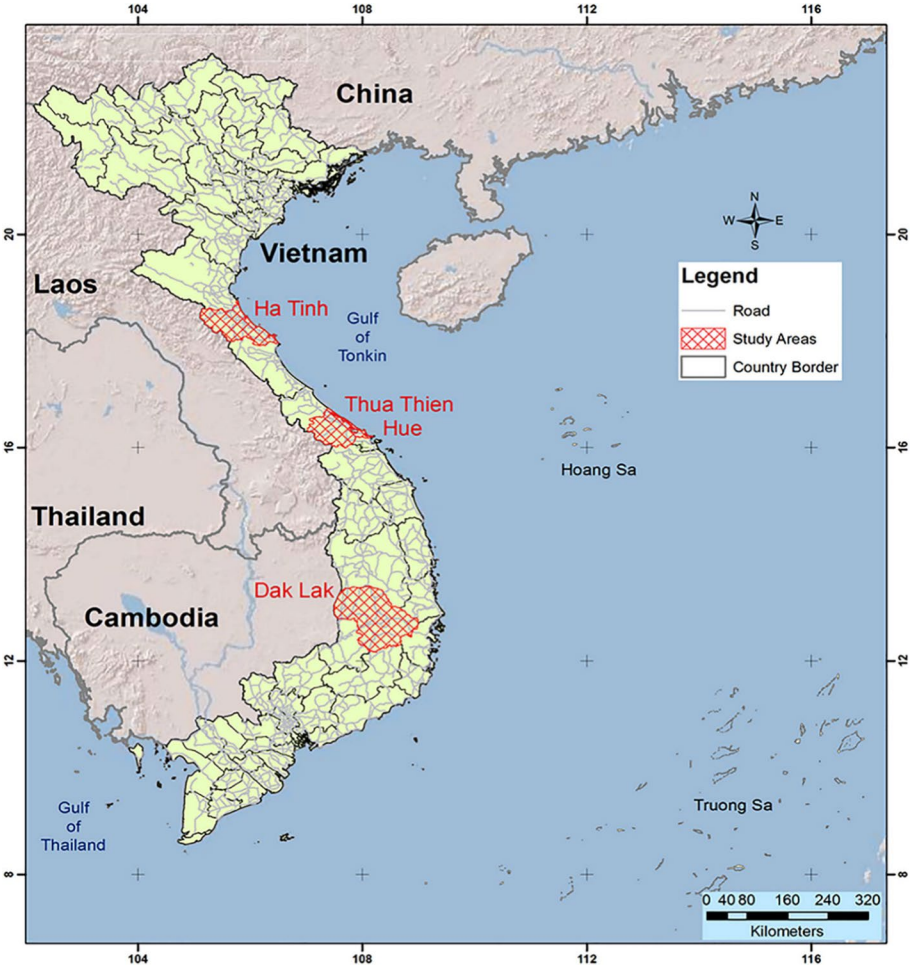

Fig. 1 Study sites of the Thailand Vietnam Socio-Economic Panel project in Central Vietnam. *Source* Nguyen et al. (2021)

study, due to the fact that the village information was not available in the most recent wave of 2017, we use a balanced panel of 1227 identical households in two recent waves with village data (2013 and 2016). The reduced sample is equal to the attrition rate of 8.8% per wave compared with the original sample in the first wave of 2007. The reasons for this reduction are that we employ the data of identical households (who participated in both waves) and households with missing data are excluded. Hence, the final sample includes 2454 observations in Vietnam for the year of 2013 and 2016.

Besides the TVSEP data, we employ the data from the rural, agricultural, and fishery census of the General Statistics Office of Vietnam (GSO) (see www.gso.gov.vn/en/rural-agricultural-and-fishery-census/ for further information). This census has been conducted in every 5 years. In particular, we use the data for the implementation results of rural development program in the wave of 2016. Together with the TVSEP data, our

data set can capture the before- and after-period of the national rural development program introduced in 2014 (Do & Park, 2019).

To instrument the variables representing households' resilience in our study, we use the rainfall data from the Tropical Rainfall Measuring Mission (TRMM) (see Kummerow et al. (1998) for the sensors and data algorithms of TRMM). The precipitation data from the TRMM is spatial with $0.25° \times 0.25°$ resolution and temporal with 3-hourly daily records. It is important to note that the data from TRMM are only available for the period of 1998 to 2014.

3.2 Data Description

Table 1 shows the descriptive summary of household characteristics. Regarding the demographic characteristics, the heads of rural households in Vietnam have a risk-attitude level of 6.06 which is slightly above the risk-neutral level (0 = unwilling to take risk and 10 = fully prepared to take risk). There is a significant increase of households' willingness to take risk from 5.93 points in 2013 to 6.19 points in 2016, however, the level of risk attitude is not significantly different between households in the groups of reduced consumption and not reduced consumption due to shocks. The dependency ratio of Vietnamese households is about 1.41 and the size of households is nearly four members on average. Male heads are dominant in these households and the heads have an average age of 54 years old. Two thirds of household heads were born in the same as the current village where they are living. The average schooling years of heads and adult members in the households are 6.9 and 5.3 years, respectively. With regard to social and physical capital, the total land areas, the number of household members engaging in farming, and asset values per capita do not show a significant difference between 2013 and 2016, the accumulated savings per capita in last year increases significantly from about PPP$ 1200 per capita to PPP$ 2200 per capita.

The descriptive summary of village and commune characteristics presented in Table 2 denotes two remarkable details. First, the village's indicators of infrastructure development has a modest improvement in the share of households with phone and cable internet at home between 2013 and 2016. The commune's indicators of rural development program show that, by 2016, more than 90% of the communes in our dataset achieved the standard of having master planning for socio-economic development. However, the other indicators including the achievements of the standard of irrigation, the standard of roads for transportation, and the standard of rural markets under the new rural development program show a moderate development with 59%, 29%, and 45% of the communes, respectively. Second, households living far from the district and province centers or in villages and communes with lower shares of household with phone and cable internet at home appear to be more likely to have consumption reduction due to shocks. The differences of these village and commune characteristics are significant between the two groups.

Figure 2 illustrates the eight most popular coping strategies against shocks in rural Vietnam between 2013 and 2016. We can clearly see that savings and income diversification are among the most popular *ex post* strategies to deal with shocks, followed by selling livestock or assets, borrowing from relatives, diversifying agro-portfolio, asking help from relatives, using insurance, and borrowing from informal lenders. While savings and income diversification remain the two most important strategies for households in the non-asset poor group, these strategies have a rising role in coping with shocks for households in asset poor group. At this point, the question arises whether savings and income diversification

Table 1 Descriptive summary of household characteristics

Variables	Whole sample (n = 2454)	By years		By reduced consumption due to shocks	
		2013 (n = 1227)	2016 (n = 1227)	No-reduction (n = 1424)	Yes-reduction (n = 1030)
Demographic characteristics					
Risk attitude of head	6.06	5.93	6.19***,a	6.06	6.06a
	(2.43)	(2.58)	(2.27)	(2.48)	(2.36)
Dependency ratio	1.41	1.53	1.28***,a	1.40	1.41a
	(0.65)	(0.63)	(0.65)	(0.66)	(0.65)
Male head (yes = 1)	0.82	0.83	0.81b	0.83	0.81b
	(0.38)	(0.37)	(0.39)	(0.37)	(0.39)
Age of head (years)	54.06	52.93	55.19***,a	54.74	53.12***,a
	(12.39)	(12.48)	(12.21)	(12.59)	(12.05)
Household size (persons)	3.95	4.07	3.82***,a	3.84	4.09***,a
	(1.69)	(1.73)	(1.64)	(1.67)	(1.70)
Schooling years of head (years of schooling)	6.90	7.01	6.78a	7.12	6.59***,a
	(3.86)	(3.87)	(3.86)	(3.89)	(3.80)
Mean education of adult members (years of schooling)	5.29	5.36	5.23a	5.43	5.10***,a
	(2.89)	(2.90)	(2.88)	(3.04)	(2.66)
Head born in the village (yes = 1)	0.67	0.67	0.67b	0.67	0.66b
	(0.47)	(0.47)	(0.47)	(0.47)	(0.47)
Social and physical capital					
Total land area (hectares)	1.13	1.13	1.13a	1.08	1.20a
	(2.30)	(2.74)	(1.75)	(2.23)	(2.40)
Farming laborers (persons)	2.08	2.06	2.10a	1.94	2.28 ***,a
	(1.15)	(1.15)	(1.15)	(1.10)	(1.18)
Asset per capita (PPP$)	905.77	863.99	947.54a	998.80	777.14***,a
	(1412.44)	(1306.86)	(1510.04)	(1639.69)	(1004.62)

Table 1 (continued)

Variables	Whole sample (n = 2454)	By years		By reduced consumption due to shocks	
		2013 (n = 1227)	2016 (n = 1227)	No-reduction (n = 1424)	Yes-reduction (n = 1030)
Last year savings per capita (PPP$)	1715.36	1239.29	2191.44***,a	2209.28	1032.51***,a
	(5833.49)	(5500.73)	(6113.53)	(7146.80)	(3111.87)

Standard deviations in parentheses; Statistic tests by years and groups of reduced consumption due to shocks;

[a]Two-sample t-test; [b]Non-parametric two-sample rank-sum test;

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Table 2 Descriptive summary of village and commune characteristics

Variables	Whole sample (n = 2454)	By years		By reduced consumption due to shocks	
		2013 (n = 1227)	2016 (n = 1227)	No-reduction (n = 1424)	Yes-reduction (n = 1030)
Village characteristics					
Number of enterprises	0.83	0.95	0.71***,a	0.92	0.70***,a
	(2.28)	(2.65)	(1.82)	(2.46)	(1.99)
Share of households with phone at home (%)	88.14	84.69	91.60***,a	88.67	87.41a
	(21.82)	(24.82)	(17.69)	(21.36)	(22.43)
Share of households with home cable internet (%)	6.78	4.20	9.37***,a	7.85	5.31***,a
	(11.10)	(6.99)	(13.57)	(12.42)	(8.74)
Distance to province center (km)	37.78	37.97	37.60a	36.35	39.76***,a
	(24.87)	(25.28)	(24.46)	(24.25)	(25.58)
Distance to district center (km)	11.15	11.07	11.22a	10.62	11.88***,a
	(8.63)	(7.89)	(9.31)	(8.17)	(9.17)
Commune characteristics					
Achieved standard of planning (yes = 1)	0.48	0.00	0.96***,b	0.51	0.44***,b
	(0.50)	(0.00)	(0.19)	(0.50)	(0.50)
Achieved standard of irrigation (yes = 1)	0.30	0.00	0.59***,b	0.32	0.26***,b
	(0.46)	(0.00)	(0.49)	(0.47)	(0.44)
Achieved standard of roads for transportation (yes = 1)	0.15	0.00	0.29***,b	0.16	0.12***,b
	(0.35)	(0.00)	(0.45)	(0.37)	(0.33)
Achieved standard of rural markets (yes = 1)	0.23	0.00	0.45***,b	0.25	0.20***,b
	(0.42)	(0.00)	(0.50)	(0.43)	(0.40)
Share of households with access to electricity (%)	95.61	94.37	96.86***,a	95.85	95.28a
	(13.85)	(15.97)	(11.22)	(14.10)	(13.50)

Standard deviations in parentheses; Statistic tests by years and groups of reduced consumption due to shocks; [a]: Two-sample t-test; [b]: Non-parametric two-sample rank-sum test

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

also play a certain role in building *ex ante* resilience strategies against shocks and improving welfare of rural households.

3.3 Measurement of Income Diversification

In this study, we aims to identify the factors affecting savings accumulation and income diversification as household's resilience strategy and examine the effects of these strategies on mitigating shocks' impacts and reducing poverty. Therefore, this sub-section describes how we measure income diversification. We use the method proposed by Gibbs and Martin (1962) to calculate the index of diversification. We follow the guideline of International Labour Organisation (ILO, 2003) to classify the income generating activities into four groups of (1) farm-related activities including crop production, livestock, and hunting/collecting natural products; (2) wage-employment activities; (3) self-employment activities; and (4) other activities and sources such as remittances, rent, transfer, and compensation. Then, the diversification index of income relied on the Gibbs and Martin's method are calculated as:

$$Income\ diversification = 1 - \sum_{m=1}^{N} S_m^2 \tag{1}$$

In Eq. (1), S is the share of income from a specific source *m* in total household income. This income diversification ranges from zero indicating no-diversification (the household has income from only one source) to one representing higher extent of diversification. The Gibbs and Martin's diversification index takes into account of not only the number of income sources, but also the concentration of income from each source.

Table 3 shows the descriptive statistics of household income and income diversification indexes. Income from agriculture has a dominant position accounting for nearly 40% of total household income. However, the share of income from this source shows a decreasing trend from 42.5% in 2013 to 37.4% in 2016. Besides, it appears that households in the group of reduced consumption due to shocks have a higher share of income from agricultural activities (at 43%) compared with about 37.5% of those in the no-reduced consumption group. It is noticeable that households, which do not have to reduce their consumption to cope with shocks, have higher shares of income from self-employment and other sources. They also have higher daily income per capita at an average of PPP$ 7.3 compared with PPP$ 5.59 of those who have to reduce consumption to cope with shock.

3.4 Measurement of Poverty

We use different methods to measure poverty in this study. The first two methods are the measurements using relative and absolute terms (Foster, 1998). Absolute poverty is based on a fixed poverty line at which people are classified as poor if their standard of living is at/lower than the threshold. In this regard, we use the World Bank's poverty threshold for middle-income countries at a daily income per capita of PPP$ 3.20 (WB, 2018a). However, this fixed cut-off might not well reflect the multidimensionality of poverty or the aspect of inequality (Clark et al., 2010; Mauro et al., 2018). Meanwhile, relative poverty is a flexible way to measure poverty using a living standard of a specific community in a particular period rather than a fixed threshold over time. In our study, we calculate the mean income

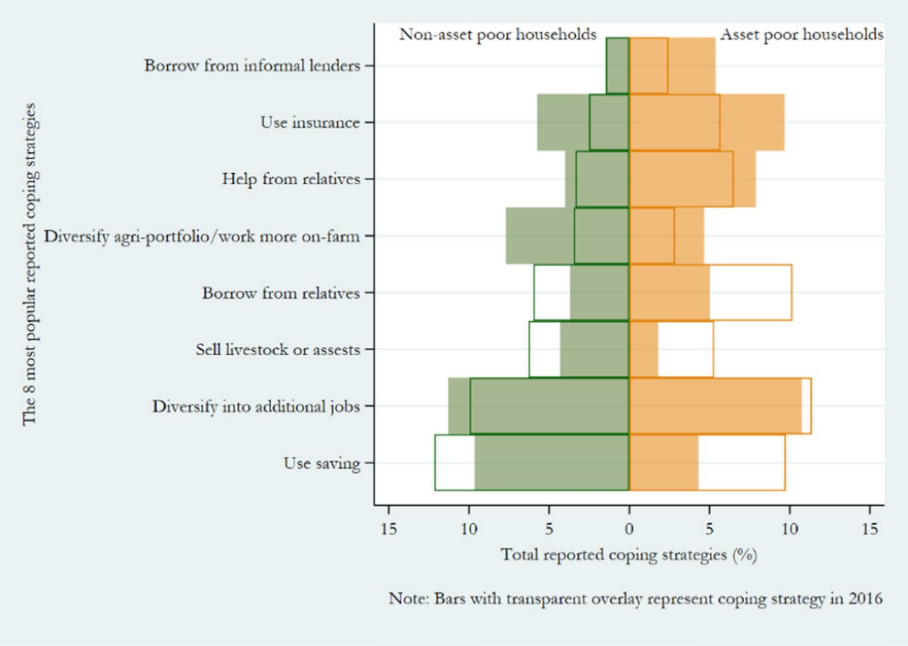

Fig. 2 Share of households' (*ex post*) coping strategies against shocks in 2013 and 2016

of all households in each year. Those households having the income that is 50% lower than the means are considered as relative income poverty.

Besides the above methods, we also use the measure of multidimensional poverty suggested by the World Bank (WB, 2018b) and adopt its multidimensional poverty measure indicators because poverty or human development should be measured in multidimensional aspects for sustainable development (Alaimo & Maggino, 2020; Anand & Sen, 1997). We take into account four dimensions of households, namely (1) monetary measure; (2) education measure; (3) access to basic infrastructure; and (4) housing and living conditions. Each group is weighted equally. The detailed measurement of all indicators is presented in Panel A3 of Appendix 1 and the adopted measure is showed in Appendix 2. We put more emphasis on child health as an indicator of living conditions because it is important in rural areas of developing countries and has critical implications for human development and households' livelihoods (Trani et al., 2013). We set the cut-off level at 0.25 (i.e., one-fourth). In other words, households fall into multidimensional poverty if they have the total number of parameters adding up to 0.25 or more. Table 4 stacks the descriptive summary of parameters for multidimensional poverty measurement and poverty indicators. It appears that the poverty rates were lower in 2016, however, they remained higher than 20% in all three different measurements. Besides, households in the group of reduced consumption due to shocks have a higher rate of poverty in all measurements compared with those in the other group.

4 Research Method

4.1 Identifying the Factors Affecting Households' Resilience Strategy

In this step, we examine the role of risk attitude in defining households' resilience strategy. Since we have a panel data, we use fixed-effects method to account for un-observable characteristics of each household. The econometric model of resilience capacity with fixed-effects estimations are specified as follows:

$$S_{it} = \alpha + \beta R_{it} + \gamma X_{it} + \delta V_{it} + \theta C_{it} + \varepsilon_{it} \quad (2)$$

In Eq. (2), S_{it} is household's i resilience strategy at time t. It can be either (1) savings per capita (estimated in logarithm) as the absorptive capacity or (2) income diversification as the adaptive capacity. R_{it} is the risk attitude of household head. X_{it} is the groups of household's demographic characteristics, social and physical capital. V_{it} is a group of village's characteristics where the household is living. C_{it} consists of commune characteristics (The variables in this group are also representing the indicators of Vietnam's new rural development program). In this regard, we use these village and commune variables as a proxy of transformative capacity and program intervention as suggested by Ansah et al. (2019). ε_{it} is the error terms.

The risk attitude is evidently endogenous (Gloede et al., 2015; Nguyen et al., 2022b). We address this problem by using an instrumental variable (IV) estimation for panel-data

Table 3 Descriptive summary of income and diversification indexes

Variables	Whole sample (n = 2454)	By years		By reduced consumption due to shocks	
		2013 (n = 1227)	2016 (n = 1227)	No-reduction (n = 1424)	Yes-reduction (n = 1030)
Share of income sources					
Agriculture (%)	39.96	42.52	37.41***,a	37.53	43.33***,a
	(32.02)	(32.98)	(30.83)	(31.42)	(32.55)
Wage employment (%)	24.99	25.87	24.11a	24.87	25.16a
	(29.16)	(29.93)	(28.35)	(29.41)	(28.81)
Self-employment (%)	11.36	11.31	11.41a	12.92	9.20***,a
	(23.72)	(23.93)	(23.51)	(24.96)	(21.71)
Other sources (%)	23.69	20.31	27.07***,a	24.68	22.32**,a
	(27.86)	(25.83)	(29.37)	(28.69)	(26.62)
Income and diversification index					
Daily income per capita (PPP$)	6.59	5.40	7.78***,a	7.30	5.59***,a
	(7.59)	(6.48)	(8.39)	(7.98)	(6.89)
Income diversification index	0.39	0.38	0.40***,a	0.39	0.38a
	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)

Standard deviations in parentheses; Statistic tests by years and groups of reduced consumption due to shocks

[a]Two-sample t-test

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

with two-stage least squares method. In this case, we employ two IVs at village level, namely total losses from covariate shocks in last year (time $t-1$) and number of households having access to electricity each village. The rationale behind these variables is that covariate shocks and the level of infrastructure development were found to have significant correlations with rural households' willingness to take risk (Liebenehm, 2018). We further run additional estimations to validate the appropriateness of these variables as the IVs of risk attitude. The results from Appendix 3 confirm that these variables are not significantly correlated with the dependent variables in Eq. (2). Besides, we carry out three quality tests for the IVs including the under-identification test (a LM test based on Kleibergen and Paap (2006)), the over-identification test (Hansen J statistic test), and the weak identification test (Kleibergen-Paap rk Wald F statistics) to statistically check for the appropriateness of these IVs in our estimations. The results of these tests showed in the post-estimation section of Table 4 indicate that the IVs are valid. We check for the problem of multicollinearity in our independent variables by using the Variance Inflation Factor (VIF). The results of VIF values of independent variables included in Eq. (2) do not show a problem of multicollinearity (see Appendix 4 for the detailed VIF values). We cluster our estimations at commune level to have robust standard errors.

4.2 Examining the Impacts of Resilience Strategy on Shocks and Poverty

In this step, we assess the impacts of households' resilience strategy (i.e. accumulating savings or diversifying income) on shocks and poverty. Again, we use fixed-effect estimations to take the advantages of panel data. The fixed-effects model to estimate the impacts of households' strategy for improving their resilience can be expressed as:

$$Y_{it} = \vartheta + \rho R_{it} + \varphi X_{it} + \phi V_{it} + \mu_{it} \tag{3}$$

In Eq. (3), Y_{it} is the dummy indicators of shocks and poverty from household i at time t (Yes = 1; otherwise = 0). Y_{it} can be (1) the *ex post* consumption reduction due to shocks, (2) relative income poverty at 50% lower than average income in each year, (3) absolute income poverty at daily income per capita of PPP$ 3.20, or (4) multidimensional poverty. R_{it} is either savings per capita or income diversification. X_{it} and V_{it} are the groups of household's demographic characteristics, social and physical capital, and village's characteristics as mentioned in Eq. (2). μ_{it} is the error terms.

We address the endogeneity problem of household's resilience strategy (R_{it}) in Eq. (3) by using the fixed-effects with IV for panel-data estimations. In this regard, we construct an IV based on the rainfall data from the TRMM as mentioned in the data section. First, we follow Jones and Hulme (1996) to calculate the Standardized Rainfall Anomaly Index (SRAI) for each month of a year. It is necessary to recall that the rainfall data from TRMM is available for the period of 1998–2014. So, this SRAI is calculated based on the long-term average precipitation between 1998 and 2014. Next, we consider a month with extreme rainfall if the SRAI is less than—1.0 or higher than 1.0. Then, we count the number of months in a year with extreme rainfall. Finally, we use the lagged 2-years number of months with extreme rainfall as the IV for savings and income diversification variables. Besides the availability of rainfall data, the reason for using this lagged IV is that the shocks (i.e. extreme precipitation) in the previous years might affect households' resilience strategy (i.e. accumulating savings or diversifying income) in the current year because of the households' responding actions to the

Table 4 Descriptive summary of multidimensional poverty parameters and poverty indicators

	Whole sample (n = 2454)	By years		By reduced consumption due to shocks	
		2013 (n = 1227)	2016 (n = 1227)	No-reduction (n = 1424)	Yes-reduction (n = 1030)
Parameters of multidimensional poverty					
Income poverty (yes = 1)	0.37	0.46	0.28***,a	0.32	0.45***,a
	(0.48)	(0.50)	(0.45)	(0.47)	(0.50)
Asset poor (yes = 1)	0.20	0.20	0.20a	0.18	0.23***,a
	(0.40)	(0.40)	(0.40)	(0.38)	(0.42)
No schooling of school-age children (yes = 1)	0.06	0.08	0.03***,a	0.05	0.07a
	(0.23)	(0.28)	(0.17)	(0.22)	(0.25)
No primary education of adult members (yes = 1)	0.01	0.01	0.01a	0.01	0.00***,a
	(0.09)	(0.10)	(0.09)	(0.11)	(0.05)
Malnourished child (yes = 1)	0.12	0.14	0.10***,a	0.11	0.13a
	(0.33)	(0.35)	(0.30)	(0.32)	(0.34)
Unsafe drinking water (yes = 1)	0.65	0.69	0.61***,a	0.62	0.69***,a
	(0.48)	(0.46)	(0.49)	(0.49)	(0.46)
No improved sanitation (yes = 1)	0.55	0.62	0.47***,a	0.49	0.63***,a
	(0.50)	(0.49)	(0.50)	(0.50)	(0.48)
No access to electricity (yes = 1)	0.02	0.02	0.02a	0.02	0.02a
	(0.14)	(0.13)	(0.15)	(0.14)	(0.14)
Poor living conditions (yes = 1)	0.15	0.19	0.11***,a	0.13	0.18***,a
	(0.36)	(0.39)	(0.32)	(0.33)	(0.38)
Poverty indicators					
Relative poverty at 50% lower than average income (yes = 1)	0.38	0.41	0.35***,a	0.33	0.46***,a
	(0.49)	(0.49)	(0.48)	(0.47)	(0.50)

Table 4 (continued)

	Whole sample (n = 2454)	By years		By reduced consumption due to shocks	
		2013 (n = 1227)	2016 (n = 1227)	No-reduction (n = 1424)	Yes-reduction (n = 1030)
Absolute poverty at a daily income per capita of PPP$ 3.20 (yes = 1)	0.37	0.46	0.28***,a	0.32	0.45***,a
	(0.48)	(0.50)	(0.45)	(0.47)	(0.50)
Multidimensional poverty (yes = 1)	0.38	0.46	0.30***,a	0.33	0.45***,a
	(0.49)	(0.50)	(0.46)	(0.47)	(0.50)

Standard deviations in parentheses; Statistic tests by years and by consumption reduction groups; [a]: Non-parametric two-sample rank-sum test

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

vulnerable context. We conduct two tests, namely the under-identification test and the weak identification test to validate the use of this IV in our estimations. The results of these tests presented in the post-estimation section of Tables 5, 6 confirm the appropriateness of this IV.

One might argue that, as the resilience capacity of households, the two variables of savings per capita as the absorptive capacity and income diversification as the adaptive capacity should be estimated in one single model because rural households might implement strategies to improve both capacities. We, therefore, run additional estimations with two endogenous variables. We employ an instrumental variable (IV) approach following the heteroscedasticity-based identification strategy proposed by Lewbel (2012). The Eq. (3) can be re-written as:

$$Y_{it} = \vartheta + \tau R^{s}_{it} + \varsigma \mathrm{R}^{d}_{it} + \varphi X_{it} + \phi \mathrm{V}_{it} + \mu_{it} \tag{4}$$

where the savings per capita and income diversification are denoted as R^{s}_{it} and R^{d}_{it}, respectively. Theoretically, this heteroscedasticity-based IV (Hetero-IV) method uses the estimated residuals (Z vector) of included independent variables (X_{it} and V_{it}) from the first stage to create internal IVs for the second stage. The Z vector can be some or the entire element of the included independent variables (Baum & Lewbel, 2019). In addition, Baum et al. (2012) recommended using external instrument variables to improve the effectiveness of this hetero-IV method. We, hence, employ the lagged 2-years number of months with extreme rainfall as one of external IVs. Besides, we follow Kim et al. (2019) to calculate the share of days having ≥ 30 mm of precipitation in a year and use the lagged 2-years share of days with heavy rainfall as the second external IV. These external IVs are truly exogenous and, thus, appropriate for the hetero-IV method. The two endogenous variables are regressed in the first stage as:

$$R^{s}_{it} = \zeta + IV'_{it}\eta_1 + X'_{it}\eta_2 + V'_{it}\eta_3 + \xi_s \tag{5}$$

$$R^{d}_{it} = \tau + IV'_{it}\sigma_1 + X'_{it}\sigma_2 + V'_{it}\sigma_3 + \xi_d \tag{6}$$

$$R^{s}_{it} * R^{d}_{it} = \Phi + IV'_{it}\upsilon_1 + X'_{it}\upsilon_2 + V'_{it}\upsilon_3 + \xi_{sd} \tag{7}$$

In addition to the two external IVs (denoted as IV_{it} in Eqs. 5, 6, and 7), Lewbel (2012) suggested to use the estimated residuals $\left[Z_{it} - \overline{Z}\right]' \hat{\xi}$ as internal IVs for R^{s}_{it} and R^{d}_{it} in estimating Eq. (4), where $\hat{\xi} = \left[\hat{\xi}_s, \hat{\xi}_d, \hat{\xi}_{sd}\right]$ is the predicted residuals. Importantly, this approach assumes there is an existence of heteroscedasticity in the model of Eq. (4). We check for the presence of heteroscedasticity in our model (Eq. 4) by employing the Pagan–Hall statistic for homoscedastic, the White's test for homoscedasticity, and the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity. The results of these tests (presented in Appendix 6) confirm the presence of heteroscedasticity in the model of Eq. (4). Therefore, the use of this Hetero-IV approach is appropriate. Further, we conduct three quality tests of IV specification models, namely the under-identification test, the weak identification test, and the over-identification test to validate the appropriateness of these IVs. The results of these tests presented in the post-estimation part of Tables 6, 7 show that these IVs are valid. Then, we check for the problem of multicollinearity by using the VIF values. The results of VIF values of the independent variables in Eq. (4) do not show a serious problem of

multicollinearity (see Appendix 5 for the detailed VIF values). The robust standard errors are clustered at commune level.

5 Results and Discussion

5.1 Factors Affecting Households' Resilience Strategy

Table 5 stacks the results of the factors affecting the accumulation of savings or diversification of income as households' resilience-building strategies. It appears that the risk attitude of household head has a negative and significant correlation with savings per capita and income diversification. In other words, the lower the willingness to take risk of household heads, the higher the level of savings accumulation and income diversification. This finding sheds light on the empirical evidence on the role of risk attitude in driving households' resilience-building strategies (Ansah et al., 2019). Under uncertainties, there is a positive demand for savings as a precautionary strategy to cope with unexpected events and for income diversification as an adaption to shocks (Arslan et al., 2018; Leland, 1978; Yang et al., 2021a).

With regard to savings, we find that the age of heads and the assets of household have positive and significant correlations with households' savings per capita. These results are in line with the findings from Baidoo et al. (2018) for both the head age and household assets, Nwosu et al. (2020) for the head age, and Panman et al. (2022) for household assets. Regarding income diversification, the mean education of household members and number of members working in farming activities have a positive and significant correlation with the diversification of income portfolios. The results are consistent with the previous studies because households engaging in farming can work in other activities during off-season periods and households with better education are more likely to participate in non-farm employment or income diversification (Arslan et al., 2018; Do et al., 2022; Memon et al., 2020; Nguyen et al., 2021).

Among village variables, it appears that the number of enterprises has a positive and significant correlation with both households' savings and income diversification. This result is reasonable because the availability of enterprises in villages implies a better opportunity to participate in non-farm work that have relatively higher income (Do et al., 2019). In the case of commune variables, households living in communes with good planning have higher level of savings and income diversification. Strategic planning is extreme important for socio-economic development (Kuroda et al., 2008). Furthermore, households in communes with better irrigation appear to have a positive and significant correlation with savings, while those living in communes with better roads tend to have less savings. The relationship between irrigation and savings is understandable because better irrigation has a positive effect on households' income (Do & Park, 2019). The negative correlation of roads with savings can be mainly because banks tend to locate in places having better road infrastructure (Binswanger et al., 1993). Households living in communes with better roads might easily have access to credit and loans from banks, hence, they might not need to keep a part of their income as savings.

From the above results, we can see that, in the absence of a proper insurance market, risk-averse households tend to build up their on absorptive and adaptive capacity to fight against the vulnerable context in rural areas. At this point, the question arises whether these resilience-building strategies might help them reduce the negative impacts of shocks

Table 5 Factors affecting the accumulation of savings and the diversification of households' income

	Savings per capita (ln)	Income diversification
Risk attitude of head	− 0.826*	− 0.047*
	(0.434)	(0.024)
Dependency ratio	0.149	0.026
	(0.295)	(0.018)
Male head[a]	0.111	0.008
	(0.581)	(0.038)
Age of head	0.038*	− 0.001
	(0.023)	(0.001)
Household size	− 0.029	0.008
	(0.118)	(0.007)
Schooling years of head	0.044	− 0.001
	(0.054)	(0.003)
Mean education of adult members	0.064	0.008***
	(0.062)	(0.003)
Head born in the village[a]	0.664	0.019
	(0.691)	(0.050)
Total land area	0.000	− 0.000
	(0.033)	(0.002)
Farming laborers	− 0.061	0.015*
	(0.143)	(0.008)
Asset per capita (ln)	0.507***	0.013
	(0.126)	(0.009)
Number of enterprises	0.120***	0.004**
	(0.039)	(0.002)
Share of households with phones	− 0.002	− 0.000
	(0.005)	(0.000)
Share of households with home cable internet	0.009	0.000
	(0.015)	(0.001)
Distance to province center	0.002	− 0.000
	(0.011)	(0.001)
Distance to district center	− 0.009	0.000
	(0.018)	(0.001)
Achieved standard of planning[a]	0.628**	0.035**
	(0.306)	(0.017)
Achieved standard of irrigation[a]	0.739*	0.015
	(0.439)	(0.024)
Achieved standard of roads for transportation[a]	− 0.801*	− 0.007
	(0.426)	(0.024)
Achieved standard of rural markets[a]	0.538	0.013
	(0.368)	(0.022)
Share of households with access to electricity	− 0.018	− 0.001
	(0.013)	(0.001)

Table 5 (continued)

	Savings per capita (ln)	Income diversification
Constant	2.390	0.583***
	(3.368)	(0.188)
Number of observations	2454	2454
Wald chi2(21)	99.74	215.14
Prob > chi2	0.000	0.000
Under identification	0.018	0.018
Over identification	0.544	0.473
Weak identification	11.596	11.596

Robust standard errors clustered at commune level

The under-identifying test is an LM test relied on the rk LM statistics (Kleibergen and Paap, 2006) with the null hypothesis stating that the model is under-identified. The over-identifying test based on the Hansen J test with the null hypothesis stating that all instruments are valid in the model. The reported values of under-identification and over-identification tests are *p* values. The report of weak-identifying test uses the Kleibergen-Paap rk Wald F statistics

[a]Dummy variable; ln: natural logarithm

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

and, at the same time, prevent them from falling into poverty. Hence, empirical evidence is needed to validate the role of savings and income diversification in helping households fight against shocks in the vulnerable context of rural areas in developing countries.

5.2 Impacts of Resilience Strategy on Shocks and Poverty

Table 6 presents the effects of savings and income diversification on consumption reduction due to shocks from fixed-effects (FE) with IVs and Hetero-IV estimations. The dependent variable in these estimations is a dummy variable denoting if the household has to reduce their consumption to cope with shocks is equal to one and otherwise is zero. If a household has a consumption reduction due to shocks, their absorptive and adaptive capacity are not enough for *ex ante* preparation. The results show that savings and income diversification have a negative and significant impact on the variable of reduced consumption caused by shocks in both the FE-IV and Hetero-IV method. Our results are in the same vein as the findings from Smith and Frankenberger (2018) who found that, in the exposure to flood shocks, an improved resilience capacity could help to reduce hunger scores and increase months of adequate food. These findings imply that improving savings as the absorptive capacity and income diversification as the adaptive capacity of household resilience significantly helps rural households have a better *ex ante* preparation to reduce the negative effects of shocks. The improvement of these financial and economic resources is important to enhance rural households' resilience under adverse financial situations (Salignac et al., 2022). While the empirical evidence on the impacts of resilience strategies on shocks are scarce, these findings enrich the literature on the effect of resilience against shocks in developing countries.

Table 6 Effects of savings and income diversification on households' consumption reduction due to shocks

	FE-IV		Hetero-IV
	With savings per capita (ln)	With income diversification	
Savings per capita (ln)	− 0.067**		− 0.041**
	(0.030)		(0.018)
Income diversification		− 1.795*	− 0.838**
		(0.931)	(0.348)
Dependency ratio	0.042	0.069*	− 0.026
	(0.031)	(0.038)	(0.016)
Male head[a]	− 0.085	− 0.061	− 0.057*
	(0.088)	(0.109)	(0.031)
Age of head	− 0.001	− 0.006	− 0.002**
	(0.003)	(0.004)	(0.001)
Household size	0.004	0.018	0.012
	(0.015)	(0.018)	(0.008)
Schooling years of head	− 0.008	− 0.013	0.002
	(0.008)	(0.011)	(0.003)
Mean education of adult members	− 0.003	0.007	− 0.003
	(0.008)	(0.011)	(0.005)
Head born in the village[a]	− 0.024	− 0.047	0.022
	(0.093)	(0.108)	(0.027)
Total land area	0.003	0.002	− 0.000
	(0.007)	(0.006)	(0.004)
Farming laborers	0.030	0.061**	0.055***
	(0.021)	(0.024)	(0.012)
Asset per capita (ln)	0.031	0.019	0.021
	(0.020)	(0.017)	(0.014)
Number of enterprises	0.003	0.001	− 0.003
	(0.005)	(0.005)	(0.003)
Share of households with phones	− 0.001	− 0.001	− 0.001
	(0.001)	(0.001)	(0.001)
Share of households with home cable internet	− 0.002	− 0.002	− 0.003**
	(0.002)	(0.002)	(0.001)
Distance to province center	− 0.002	− 0.002*	0.000
	(0.001)	(0.001)	(0.000)
Distance to district center	0.001	0.002	0.001
	(0.002)	(0.002)	(0.001)
Constant		− 1.795*	− 0.838**
		(0.931)	(0.348)
Number of observations	2454	2454	2454
Wald chi2(16)	132.50	101.78	
Prob > chi2	0.000	0.000	
F(17, 102)			6.13
Prob > F			0.000
Under identification	0.000	0.001	0.001

Table 6 (continued)

	FE-IV		Hetero-IV
	With savings per capita (ln)	With income diversification	
Weak identification	44.532	13.884	10.825
Over identification			0.272

Robust standard errors clustered at commune level

The under-identifying test is an LM test relied on the rk LM statistics (Kleibergen and Paap, 2006) with the null hypothesis stating that the model is under-identified. The over-identifying test based on the Hansen J test with the null hypothesis stating that all instruments are valid in the model. The reported values of under-identification and over-identification tests are *p* values. The report of weak-identifying test uses the Kleibergen-Paap rk Wald F statistics

[a]Dummy variable; ln: natural logarithm

$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$

We also find that households' dependency ratio and number of farming laborers have a positive and significant effect, while male heads, age of heads, and the share of households with cable internet at home show a negative and significant impact on households' reduced consumption due to shocks. The result of male heads is consistent with that of Smith and Frankenberger (2018) who have pointed out that female heads are more likely to suffer from hunger score. To some extent, our results are also similar to those from D'Errico et al. (2018) for the age and gender of household heads in the case of the reduction in per capita caloric intake and dietary diversity loss.

Table 7 shows the impacts of savings and income diversification as resilience capacities on relative poverty, absolute poverty, and multidimensional poverty from FE-IV and Hetero-IV estimations. We can see that both savings and diversification of income portfolios have a negative and significant effect on relative poverty, absolute poverty, and multidimensional poverty in separate FE-IV estimations. When putting them in the same estimations, the effect remains unchanged for income diversification, but that of savings does not show a significant effect at 10% significant level. The role of income diversification in reducing poverty appears to be consistent with the previous studies (Arslan et al., 2018; Khandker, 2012). The effects of better resilience capacity on reducing poverty are similar with the findings from Haile et al. (2021), but our results are more robust because we have addressed the problem of endogeneity carefully. Our findings provide a complete picture of the diversification of income portfolios in three different aspects of poverty measurement. These findings further imply that households' resilience-building strategies could help fight against the negative impacts of shocks and, at the same time, reduce poverty.

Among the other households' characteristics, our results also show that households with higher dependency ratio, more members, with heads born in the village (local households), and more members engaging in farming activities are more likely to fall into poverty. Since a large part of rural households in Vietnam depend on rice production, more members engaging in farming might have negative effects on their income (Do et al., 2023). On the other hand, households with older heads, better education of heads, and higher assets per capita appear to be less unlikely to fall into these poverty groups. These results are in the same vein as those from Nguyen et al., (2020b), Do et al. (2022), and Yang et al. (2021b).

Table 7 Effects of savings and income diversification on poverty

	Relative poverty[a]			Absolute poverty[a]			Multidimensional poverty[a]		
	FE-IV		Hetero-IV	FE-IV		Hetero-IV	FE-IV		Hetero-IV
	With savings per capita (ln)	With income diversification		With savings per capita (ln)	With income diversification		With savings per capita (ln)	With income diversification	
Savings per capita (ln)	− 0.056**		0.048	− 0.147***		0.006	− 0.129***		0.029
	(0.022)		(0.053)	(0.027)		(0.045)	(0.025)		(0.058)
Income diversification		− 1.484**	− 1.275*		− 3.911***	− 1.636**		− 3.438***	− 1.765**
		(0.727)	(0.764)		(1.145)	(0.738)		(0.962)	(0.864)
Dependency ratio	0.015	0.037	0.091***	0.013	0.071	0.084***	− 0.010	0.041	0.078**
	(0.037)	(0.036)	(0.031)	(0.048)	(0.058)	(0.027)	(0.045)	(0.049)	(0.031)
Male head[a]	− 0.020	0.000	− 0.047	0.025	0.079	− 0.027	0.066	0.113	− 0.014
	(0.067)	(0.076)	(0.042)	(0.084)	(0.122)	(0.039)	(0.068)	(0.106)	(0.045)
Age of head	0.004	− 0.000	− 0.000	0.001	− 0.009**	− 0.001	0.003	− 0.007*	− 0.003**
	(0.003)	(0.002)	(0.001)	(0.003)	(0.004)	(0.001)	(0.003)	(0.004)	(0.001)
Household size	0.033**	0.044***	0.020**	0.023	0.054**	0.029***	0.040**	0.067***	0.032***
	(0.014)	(0.016)	(0.010)	(0.017)	(0.024)	(0.010)	(0.017)	(0.021)	(0.011)
Schooling years of head	0.008	0.004	− 0.016**	0.010	− 0.000	− 0.011*	− 0.001	− 0.010	− 0.016*
	(0.007)	(0.009)	(0.008)	(0.009)	(0.015)	(0.007)	(0.007)	(0.013)	(0.009)
Mean education of adult members	− 0.009	− 0.001	− 0.008	0.003	0.024*	− 0.005	0.002	0.020	− 0.005
	(0.006)	(0.009)	(0.007)	(0.010)	(0.013)	(0.007)	(0.009)	(0.012)	(0.008)
Head born in the village[a]	− 0.044	− 0.062	0.139**	− 0.028	− 0.077	0.126**	0.024	− 0.019	0.117
	(0.097)	(0.104)	(0.066)	(0.118)	(0.171)	(0.061)	(0.098)	(0.146)	(0.073)
Total land area	− 0.003	− 0.004	− 0.013	− 0.004	− 0.006	− 0.011	− 0.004	− 0.005	− 0.012
	(0.004)	(0.004)	(0.009)	(0.006)	(0.009)	(0.009)	(0.006)	(0.010)	(0.010)
Farming laborers	− 0.000	0.025	0.051**	0.005	0.072**	0.041*	− 0.011	0.048	0.054**
	(0.018)	(0.021)	(0.024)	(0.023)	(0.034)	(0.022)	(0.020)	(0.030)	(0.026)

Table 7 (continued)

	Relative poverty[a]			Absolute poverty[a]			Multidimensional poverty[a]		
	FE-IV		Hetero-IV	FE-IV		Hetero-IV	FE-IV		Hetero-IV
	With savings per capita (ln)	With income diversification		With savings per capita (ln)	With income diversification		With savings per capita (ln)	With income diversification	
Asset per capita (ln)	0.001	− 0.009	− 0.110***	0.035	0.009	− 0.081***	0.010	− 0.013	− 0.128***
	(0.025)	(0.021)	(0.021)	(0.021)	(0.017)	(0.018)	(0.032)	(0.023)	(0.019)
Number of enterprises	0.008*	0.007	0.002	0.020***	0.016*	0.005	0.014***	0.010	0.002
	(0.005)	(0.005)	(0.004)	(0.006)	(0.009)	(0.004)	(0.005)	(0.007)	(0.005)
Share of households with phones	0.000	− 0.000	0.000	− 0.000	− 0.001	− 0.000	0.000	− 0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Share of households with home cable internet	− 0.001	− 0.001	− 0.002*	− 0.000	− 0.001	− 0.003*	0.000	− 0.000	− 0.003**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.001)	(0.002)	(0.002)	(0.002)
Distance to province center	0.001	0.000	0.001	0.001	− 0.000	0.001	0.001	− 0.001	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Distance to district center	− 0.002	− 0.002	− 0.003	− 0.006**	− 0.005	− 0.004*	− 0.005	− 0.004	− 0.003
	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)
Constant	0.188	0.795**	1.234***	0.285	1.884***	1.290***	0.289	1.695***	1.595***
	(0.279)	(0.329)	(0.280)	(0.285)	(0.563)	(0.270)	(0.323)	(0.509)	(0.312)
Number of observations	2454	2454	2454	2454	2454	2454	2454	2454	2454
Wald chi2(16)	74.39	63.04		114.46	58.33		92.53	58.63	
Prob. > chi	0.000	0.000		0.000	0.000		0.000	0.000	
F(17, 102)			28.70			18.90			25.29
Prob. > F			0.000			0.000			0.000
Under identification	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.001	0.000
Weak identification	44.532	13.884	12.188	44.532	13.884	12.188	44.532	13.884	12.188

Table 7 (continued)

	Relative poverty[a]			Absolute poverty[a]			Multidimensional poverty[a]		
	FE-IV		Hetero-IV	FE-IV		Hetero-IV	FE-IV		Hetero-IV
	With savings per capita (ln)	With income diversification		With savings per capita (ln)	With income diversification		With savings per capita (ln)	With income diversification	
Over identification			0.088			0.111			0.168

Robust standard errors clustered at commune level

The under-identifying test is an LM test relied on the rk LM statistics (Kleibergen and Paap, 2006) with the null hypothesis stating that the model is under-identified. The over-identifying test based on the Hansen J test with the null hypothesis stating that all instruments are valid in the model. The reported values of under-identification and over-identification tests are *p* values. The report of weak-identifying test uses the Kleibergen-Paap rk Wald F statistics

[a]Dummy variable; ln: natural logarithm

$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$

Regarding the village's characteristics, we find that the number of enterprises has a positive impact on poverty, while the share of households with cable internet at home has a negative influence on absolute and relative poverty. This shows the current development of enterprises in village is not significant in contributing to poverty reduction. The reason is that not all households might engage in non-farm employment due to resource constraints (Do et al., 2022). On the other hand, the impact of the internet on reducing poverty is in a similar vein with the previous studies (Yang et al., 2021b). Our results further point out that distance to provincial center has a positive effect on multidimensional poverty and the distance to district center negatively affects absolute poverty. The result of the distance to provincial center implies that those households living far from the province center are not only vulnerable to monetary poverty (Nguyen, 2022b), but also to other conditions such as education, living condition, and housing and access to basic infrastructure.

6 Conclusion and Policy Implications

Understanding households' resilience-building strategies is vital for the domains of humanitarian assistance, economic development, food security, and poverty reduction, especially in the places where are vulnerable to shocks. In this study, we offer the first trial that takes into account of the correlation between households' risk attitude and their resilience strategy, namely savings as an absorptive capacity and income diversification as an adaptive capacity. We examine the effects of these strategies on reducing the impacts of shocks and poverty. We use a panel data of 1227 identical households for Vietnam in two waves of the Thailand–Vietnam Socio-Economic Panel (TVSEP) project to investigate the above issues. Furthermore, we address the endogenous problems of households' risk attitude, savings, and income diversification. The results show some important findings and policy implications.

First, more risk-averse households tend to save more as an absorptive capacity and diversify their income sources as an adaptive capacity. These precautionary strategies to build up their resilience capacity help prevent them from reducing consumption caused by shocks and from falling into poverty. We suggest that rural development policies in developing countries should focus on facilitating more income generation and employment opportunities such as attracting more enterprises in villages, having a strategic planning on socio-economic development, or improving irrigation system. These supportive policies should target households with low educations and assets to stimulate their participation in the diversification of income portfolios.

Second, we find that households with female heads, higher dependency ratio, more members engaging in farming activities, and living far from provincial centers are more likely to have to reduce their consumption to cope with shocks. We recommend that local governments in developing countries should pay more attention to households in these disadvantaged groups to provide them with an extra support to deal with unexpected events. Rural development programs could not only invest more in infrastructure for transportation (e.g., roads), but also infrastructure for information and communication technology (ICT) (e.g., the internet connectivity).

Last, our results further show that households that have higher dependency ratio, larger household size, higher number of members participating in farm-employment, heads born in the village, and are living in villages far from provincial centers appear to be more likely to fall into poverty. On the other hand, those households have higher education of heads

and live in villages with a higher share of households with home cable internet are less likely to be trapped in poverty. These results imply that the development of rural education and ICT infrastructure should be taken into account of designing poverty reduction programs.

Although this study has provided some useful insights of households' resilience strategy against shocks and poverty, it still has some limitations. First, we used the data collected from three provinces of a developing country in two years. Therefore, future studies should employ better samples, for example, with more provinces, or more panel waves, or even more countries to have more generalization of research results. Second, we employed two single indicators as proxies for the resilience capacities of households (i.e., savings as an absorptive capacity and income diversification as an adaptive capacity). These single indicators, however, might not well reflect the practical resilience capacities of rural households, for instance, the role of social network or local governance in preventing/mitigating the adverse impacts of shocks. Hence, future studies should use a better approach to measure the resilience capacities of rural households. These limitations should be considered in future studies related to the resilience capacities of rural households in developing countries.

Appendix

Appendix 1: Name, Definition and Measurement of Variables

Variables	Measurement	Definition
A. Household characteristics		
A1. Demographic characteristics		
Risk attitude of head	Scale from 0 to 10	The risk-attitude level of the households' head. 0 = unwilling to take risks and 10 = fully prepared to take risks
Dependency ratio	Continuous	The ratio of nucleus size and independent members (15–64 years) in the household
Male head	Dummy	Gender of the household head. Male = 1; otherwise = 0
Age of head	Years of age	Ages of the household head
Household size	Number of persons	Number of members in the household
Schooling years of head	Years of schooling	Number of schooling years of the household head
Mean schooling years of adult members	Years of schooling	Average schooling years of all adult members in the household
Head born in the village	Dummy	If the household head was born in the same as current village = 1; otherwise = 0
A2. Social and physical capital		

Variables	Measurement	Definition
Total land area	hectares (ha)	Total land areas of the household
Farming laborers	Number of persons	Number of members engaging in farming activities
Asset per capita	PPP$ (adjusted to 2005 prices)	Total asset values of both productive and non-productive asset of the household
Last year savings per capita	PPP$ (adjusted to 2005 prices)	Total amount of the household's savings per capita in the beginning of the surveyed period
A3. Multidimensional poverty		
Income poverty	Dummy	If the household falls into absolute poverty at the daily income per capita of PPP$ 3.20 = 1; otherwise = 0
Asset poor	Dummy	If the household belongs to the group of the 20% poorest of asset per capita = 1; otherwise = 0
No schooling of school-age children	Dummy	If at least one school-age child up to the age of grade 8 is not enrolled in school = 1; otherwise = 0
No primary education of adult members	Dummy	If no adults in the household (age of grade 9 or above) has completed primary education = 1; otherwise = 0
Malnourished child	Dummy	If the household has a malnourished child = 1; otherwise = 0
Unsafe drinking water	Dummy	If the household is using water from unsafe sources = 1; otherwise = 0
No improved sanitation	Dummy	If the household has no flush toilet = 1; otherwise = 0
No access to electricity	Dummy	If the household has no access to electricity for lighting = 1; otherwise = 0
Poor living conditions	Dummy	If the household has dwelling size per capita less than 10m2 = 1; otherwise = 0
B. Village characteristics		
Number of enterprises	Quantity	The number of enterprises within the village
Share of households with phone at home	Percentage (%)	Share of households having phone line at home in the village
Share of households with home cable internet	Percentage (%)	Share of households having the cable internet at home in the village
Distance to province center	Kilometer (km)	Distance from the village to the province center
Distance to district center	Kilometer (km)	Distance from the village to the district center
C. Commune characteristics		

Variables	Measurement	Definition
Achieved standard of planning	Dummy	If the commune achieved the standard of having master planning for socio-economic development (Approved and publicly announced) under the National New Rural Development program = 1; otherwise = 0
Achieved standard of irrigation	Dummy	If the commune achieved the standard of irrigation (at least 80% of total agricultural land are irrigated) under the National New Rural Development program = 1; otherwise = 0
Achieved standard of roads for transportation	Dummy	If the commune achieved the standard of transportation (inter-commune and inter-village roads are concreted and good enough for vehicle transportation) under the National New Rural Development program = 1; otherwise = 0
Achieved standard of rural markets	Dummy	If the commune achieved the standard of infrastructure for commercial purposes (having rural markets or marketplaces for commercial activities) under the National New Rural Development program = 1; otherwise = 0
Share of households with access to electricity	Percentage (%)	Share of households with access to electricity in each village of the commune
D. Instrumental variables		
Lagged losses caused by covariate shocks in the village	PPP$ (adjusted to 2005 prices)	Total losses of households at village level caused by shocks with covariate nature
Number of households having electricity in the village	Households	Number of households having electricity at village level
Lagged 2-year months with extreme rainfall	Months	Number of months with extreme rainfall (having the Standardized Rainfall Anomaly Index (SRAI) less than -1.0 or higher than 1.0))
Lagged 2-year share of days with heavy rainfall	Percentage (%)	Share of days in a year with heavy rainfall (rainfall amount higher or equal to 30 mm/day)

Appendix 2: Adopted Measure of Multidimensional Poverty

Dimension	Parameter	Weight
Monetary measure	The household has a daily income per capita at less than PPP$3.20	1/8
	The household belongs to the group of 20% poorest in term of asset per capita	1/8
Education	At least one school-age child up to the age of grade 8 is not enrolled in school in the household	1/8
	No adult (at the age of grade 9 or above) has completed primary education in the household	1/8
Access to basic infrastructure	The household is using water from unsafe sources for drinking	1/12
	The household has no improved sanitation (flush toilet)	1/12
	The household has no access to electricity for lighting	1/12
Housing and living condition	The household has an average dwelling size of less than $10m^2$ per capita	1/8
	The household has a malnourished child	1/8

Appendix 3: Estimations to Validate Instrument Variables in Resilience Strategy Models

	Risk attitude	Savings per capita (ln)	Income diversification
Dependency ratio	0.037	− 0.127	− 0.012
	(0.083)	(0.124)	(0.007)
Male head[a]	0.334**	0.401**	0.004
	(0.154)	(0.167)	(0.011)
Age of head	− 0.013***	0.008	− 0.000
	(0.005)	(0.005)	(0.000)
Household size	0.008	0.086*	0.011***
	(0.039)	(0.049)	(0.003)
Schooling years of head	0.072***	0.059**	− 0.000
	(0.017)	(0.024)	(0.002)
Mean education of adult members	0.022	− 0.009	0.005***
	(0.022)	(0.027)	(0.002)
Head born in the village[a]	− 0.190	− 0.311*	0.039***
	(0.124)	(0.170)	(0.014)
Total land area	0.019	0.077**	− 0.002
	(0.012)	(0.032)	(0.002)
Farming laborers	0.098*	− 0.208***	0.006
	(0.053)	(0.061)	(0.005)
Asset per capita (ln)	0.221***	0.623***	0.002
	(0.050)	(0.123)	(0.004)
Number of enterprises	0.026**	0.029	0.001
	(0.011)	(0.025)	(0.002)

	Risk attitude	Savings per capita (ln)	Income diversification
Share of households with phones	0.477	− 0.085	− 0.046
	(0.304)	(0.321)	(0.029)
Share of households with home cable internet	0.140	0.944	− 0.031
	(0.447)	(0.712)	(0.040)
Distance to province center	− 0.001	− 0.002	− 0.000
	(0.002)	(0.003)	(0.000)
Distance to district center	0.000	0.007	− 0.002**
	(0.007)	(0.008)	(0.001)
Achieved standard of planning[a]	0.240**	0.388*	0.023*
	(0.120)	(0.216)	(0.012)
Achieved standard of irrigation[a]	0.205	0.218	− 0.002
	(0.149)	(0.246)	(0.017)
Achieved standard of roads for transportation[a]	− 0.115	− 0.297	0.005
	(0.190)	(0.298)	(0.017)
Achieved standard of rural markets[a]	− 0.183	0.832***	0.022
	(0.139)	(0.262)	(0.016)
Share of households with access to electricity	− 0.997**	− 0.733	0.042
	(0.394)	(0.936)	(0.045)
Instrument variables			
Lagged losses caused by covariate shocks in the village	0.000**	0.000	− 0.000
	(0.000)	(0.000)	(0.000)
Number of households having electricity in the village	− 0.000	0.000	− 0.000
	(0.000)	(0.001)	(0.000)
Constant	4.743***	− 1.872	0.314***
	(0.673)	(1.647)	(0.050)
Number of observations	2454	2454	2454
F(24, 102)	10.82	12.29	4.59
Prob > chi2	0.000	0.000	0.000

Robust standard errors clustered at commune level.

[a]Dummy variable; ln: natural logarithm.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$

Appendix 4: Variance Inflation Factor (VIF) Values on the Estimation of Resilience Strategies

	VIF	1/VIF
Risk attitude of head	1.09	0.92
Dependency ratio	1.32	0.76
Male head[a]	1.16	0.86
Age of head	1.16	0.87
Household size	1.75	0.57
Schooling years of head	1.68	0.60

	VIF	1/VIF
Mean education of adult members	1.59	0.63
Head born in the village[a]	1.16	0.86
Total land area	1.12	0.89
Farming laborers	1.48	0.68
Asset per capita (ln)	1.36	0.74
Number of enterprises	1.06	0.94
Share of households with phones	1.27	0.79
Share of households with home cable internet	1.22	0.82
Distance to province center	1.22	0.82
Distance to district center	1.14	0.87
Achieved standard of planning[a]	2.02	0.49
Achieved standard of irrigation[a]	2.24	0.45
Achieved standard of roads for transportation[a]	1.93	0.52
Achieved standard of rural markets[a]	1.77	0.56
Share of households with access to electricity	1.31	0.76
Mean VIF	1.43	

[a]Dummy variable; ln: natural logarithm.

Appendix 5: Variance Inflation Factor (VIF) Values on the Effect Estimations of Consumption Reduction due to Shocks and Poverty

	FE-IV		Hetero-IV
	Savings per capita (ln)	Income diversification	
Savings per capita (ln)	1.16		1.17
Income diversification		1.04	1.05
Dependency ratio	1.28	1.28	1.29
Male head[a]	1.16	1.15	1.16
Age of head	1.15	1.14	1.15
Household size	1.74	1.75	1.75
Schooling years of head	1.65	1.65	1.65
Mean education of adult members	1.59	1.59	1.59
Head born in the village[a]	1.15	1.16	1.16
Total land area	1.12	1.12	1.12
Farming laborers	1.48	1.47	1.48
Asset per capita (ln)	1.38	1.28	1.38
Number of enterprises	1.04	1.04	1.04
Share of households with phones	1.07	1.07	1.07
Share of households with home cable internet	1.11	1.11	1.11
Distance to province center	1.20	1.20	1.20
Distance to district center	1.10	1.11	1.10
Mean VIF	1.27	1.26	1.26

[a]Dummy variable; ln: natural logarithm.

Appendix 6: Tests for Heteroscedasticity in the Hetero-IV Model of Savings and Income Diversification

	chi2(1)	Prob > chi2
Pagan–Hall statistic (White/Koenker nR2 test statistic) (Ho: Disturbance is homoskedastic)		
Accumulating savings and diversifying income	94.47	0.000
White's test for homoscedasticity (Ho: homoscedasticity)		
Accumulating savings and diversifying income	334.89	0.000
Breusch-Pagan/Cook-Weisberg test for heteroscedasticity (Ho: Constant variance)		
Accumulating savings and diversifying income	10.54	0.001

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Declarations

Conflict of interest The author(s) declare that they have no conflict of interest in this research.

References

Alaimo, L. S., & Maggino, F. (2020). Sustainable development goals indicators at territorial level: Conceptual and methodological issues—The Italian perspective. *Social Indicators Research, 147*(2), 383–419.

Anand, S., & Sen, A. K. (1997). *Concepts of human development and poverty: A multidimensional perspective. Human Development Papers*. UNDP.

Ansah, I. G. K., Gardebroek, C., & Ihle, R. (2019). Resilience and household food security: A review of concepts, methodological approaches and empirical evidence. *Food Security, 11*(6), 1187–1203.

Ansah, I. G. K., Gardebroek, C., & Ihle, R. (2021). Shock interactions, coping strategy choices and household food security. *Climate and Development, 13*(5), 414–426.

Arslan, A., Cavatassi, R., Alfani, F., Mccarthy, N., Lipper, L., & Kokwe, M. (2018). Diversification under climate variability as part of a CSA strategy in rural Zambia. *The Journal of Development Studies, 54*(3), 457–480.

Baidoo, S. T., Boateng, E., & Amponsah, M. (2018). Understanding the determinants of saving in Ghana: Does financial literacy matter? *Journal of International Development, 30*(5), 886–903.
Barrett, C. B., Ghezzi-Kopel, K., Hoddinott, J., Homami, N., Tennant, E., Upton, J., & Wu, T. (2021). A scoping review of the development resilience literature: Theory, methods and evidence. *World Development, 146*, 105612.
Baum, C. F., Lewbel, A., Schaffer, M. E., & Talavera, O. (2012). Instrumental variables estimation using heteroskedasticity-based instruments. In *United Kingdom stata user's group meetings*. Retrieved June 14, 2022, from http://fmwww.bc.edu/repec/bocode/u/UK12_baum.pdf
Baum, C. F., & Lewbel, A. (2019). Advice on using heteroskedasticity-based identification. *The Stata Journal, 19*(4), 757–767.
Béné, C., Headey, D., Haddad, L., & von Grebmer, K. (2016). Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. *Food Security, 8*(1), 123–138.
Bergstrand, K., Mayer, B., Brumback, B., & Zhang, Y. (2015). Assessing the relationship between social vulnerability and community resilience to hazards. *Social Indicators Research, 122*(2), 391–409.
Binswanger, H. P., Khandker, S. R., & Rosenzweig, M. R. (1993). How infrastructure and financial institutions affect agricultural output and investment in India. *Journal of Development Economics, 41*(2), 337–366.
Birthal, P. S., & Hazrana, J. (2019). Crop diversification and resilience of agriculture to climatic shocks: Evidence from India. *Agricultural Systems, 173*, 345–354.
Carpenter, S. R., Westley, F., & Turner, M. G. (2005). Surrogates for resilience of social–ecological systems. *Ecosystems, 8*(8), 941–944.
Clark, D., & Hulme, D. (2010). Poverty, time and vagueness: Integrating the core poverty and chronic poverty frameworks. *Cambridge Journal of Economics, 34*(2), 347–366.
D'Errico, M., Romano, D., & Pietrelli, R. (2018). Household resilience to food insecurity: Evidence from Tanzania and Uganda. *Food Security, 10*(4), 1033–1054.
DeLoach, S. B., & Smith-Lin, M. (2018). The role of savings and credit in coping with idiosyncratic household shocks. *The Journal of Development Studies, 54*(9), 1513–1533.
Do, M. H., Nguyen, T. T., Halkos, G., & Grote, U. (2022). Non-farm employment, natural resource extraction, and poverty: evidence from household data for rural Vietnam. *Environment, Development and Sustainability*, 1–38.
Do, M. H., Nguyen, T. T., & Grote, U. (2023). Land consolidation, rice production, and agricultural transformation: Evidence from household panel data for Vietnam. *Economic Analysis and Policy, 77*, 157–173.
Do, M. H., & Park, S. C. (2019). Impacts of Vietnam's new rural development policy on rural households' income: Empirical evidence from the Heckman selection model. *International Review of Public Administration, 24*(4), 229–245.
Do, T. L., Nguyen, T. T., & Grote, U. (2019). Livestock production, rural poverty, and perceived shocks: Evidence from panel data for Vietnam. *The Journal of Development Studies, 55*(1), 99–119.
FAO. (2016). *RIMA-II: Resilience index measurement and analysis – II*. The Food and Agriculture Organization of the United Nations (FAO). Retrieved June 14, 2022, from https://www.fao.org/3/i5665e/i5665e.pdf
Foster, J. E. (1998). Absolute versus relative poverty. *The American Economic Review, 88*(2), 335–341.
Gibbs, J. P., & Martin, W. T. (1962). Urbanization, technology, and the division of labor: International patterns. *American Sociological Review*, 667–677.
Gloede, O., Menkhoff, L., & Waibel, H. (2015). Shocks, individual risk attitude, and vulnerability to poverty among rural households in Thailand and Vietnam. *World Development, 71*, 54–78.
Gröger, A., & Zylberberg, Y. (2016). Internal labor migration as a shock coping strategy: Evidence from a typhoon. *American Economic Journal: Applied Economics, 8*(2), 123–153.
Haile, D., Seyoum, A., & Azmeraw, A. (2021). Does building the resilience of rural households reduce multidimensional poverty? Analysis of panel data in Ethiopia. *Scientific African, 12*, e00788.
Hardeweg, B., Klasen, S., & Waibel, H. (2013). Establishing a database for vulnerability assessment. *Vulnerability to poverty: Theory, measurement and determinants, with case studies from Thailand and Vietnam* (pp. 50–79). Palgrave Macmillan.
Hoddinott, J. (2014). Understanding resilience for food and nutrition security. In *2020 conference papers (No. 8). Building resilience for food and nutrition security*. International Food Policy Research Institute (IFPRI).
ILO. (2003). *Resolution concerning household income and expenditure statistics*. The International Labour Organisation (ILO). Retrieved June 14, 2022, from https://www.ilo.org/public/english/bureau/stat/download/res/hiestat

Jones, L., Samman, E., & Vinck, P. (2018). Subjective measures of household resilience to climate variability and change. *Ecology and Society*, *23*(1).
Jones, P. D., & Hulme, M. (1996). Calculating regional climatic time series for temperature and precipitation: Methods and illustrations. *International Journal of Climatology: A Journal of the Royal Meteorological Society, 16*(4), 361–377.
Khandker, S. R. (2012). Seasonality of income and poverty in Bangladesh. *Journal of Development Economics, 97*(2), 244–256.
Kim, I. W., Oh, J., Woo, S., & Kripalani, R. H. (2019). Evaluation of precipitation extremes over the Asian domain: Observation and modelling studies. *Climate Dynamics, 52*(3), 1317–1342.
Klasen, S., & Waibel, H. (2015). Vulnerability to poverty in South-East Asia: Drivers, measurement, responses, and policy issues. *World Development, 71*, 1–3.
Kleibergen, F., & Paap, R. (2006). Generalized reduced rank tests using the singular value decomposition. *Journal of Econometrics, 133*(1), 97–126.
Kummerow, C., Barnes, W., Kozu, T., Shiue, J., & Simpson, J. (1998). The tropical rainfall measuring mission (TRMM) sensor package. *Journal of Atmospheric and Oceanic Technology, 15*(3), 809–817.
Kuroda, H., Kawai, M., Nangia, R., Bourguignon, F., & Pleskovic, B. (2008). Infrastructure and regional cooperation. In *Rethinking infrastructure for development*. Annual World Bank Conference on Development Economics Global. The World Bank group.
Leland, H. E. (1978). Saving and uncertainty: The precautionary demand for saving. *Uncertainty in Economics* (pp. 127–139). Academic Press.
Lewbel, A. (2012). Using heteroscedasticity to identify and estimate mismeasured and endogenous regressor models. *Journal of Business and Economic Statistics, 30*, 67–80.
Liebenehm, S. (2018). Temporal stability of risk attitudes and the impact of adverse shocks—A panel data analysis from Thailand and Vietnam. *World Development, 102*, 262–274.
Liu, W., Li, J., Ren, L., Xu, J., Li, C., & Li, S. (2020). Exploring livelihood resilience and its impact on livelihood strategy in rural China. *Social Indicators Research, 150*(3), 977–998.
Mauro, V., Biggeri, M., & Maggino, F. (2018). Measuring and monitoring poverty and well-being: A new approach for the synthesis of multidimensionality. *Social Indicators Research, 135*, 75–89.
Memon, M. H., Ali, M., & Khalil, S. (2020). Determinants of income diversification in flood-prone rural Pakistan. *International Journal of Disaster Risk Reduction, 50*, 101914.
Meuwissen, M. P., Feindt, P. H., Spiegel, A., Termeer, C. J., Mathijs, E., de Mey, Y., ... & Reidsma, P. (2019). A framework to assess the resilience of farming systems. *Agricultural Systems*, *176*, 102656
Meybeck, A., Lankoski, J., Redfern, S., Azzu, N., & Gitz, V. (2012). Building resilience for adaptation to climate change in the agriculture sector. Proceedings of a Joint FAO/OECD Workshop, Rome, Italy, 23–24 April 2012. In *Building resilience for adaptation to climate change in the agriculture sector. Proceedings of a Joint FAO/OECD Workshop, Rome, Italy, 23–24 April 2012.* Food and Agriculture Organization of the United Nations (FAO). Retrieved June 14, 2022, http://www.fao.org/docrep/017/i3084e/i3084e.pdf
Nguyen, D. L., Nguyen, T. T., & Grote, U. (2022a). Shocks, household consumption, and livelihood diversification: a comparative evidence from panel data in rural Thailand and Vietnam. *Economic Change and Restructuring*, 1–33.
Nguyen, G., & Nguyen, T. T. (2020). Exposure to weather shocks: A comparison between self-reported record and extreme weather data. *Economic Analysis and Policy, 65*, 117–138.
Nguyen, T. T., Do, M. H., & Rahut, D. (2022b). Shock, risk attitude and rice farming: Evidence from panel data for Thailand. *Environmental Challenges, 6*, 100430.
Nguyen, T. T., Nguyen, T. T., Do, M. H., Nguyen, D. L., & Grote, U. (2022c). Shocks, agricultural productivity, and natural resource extraction in rural Southeast Asia. *World Development, 159*, 106043.
Nguyen, T. T., Nguyen, T. T., & Grote, U. (2020a). Multiple shocks and households' choice of coping strategies in rural Cambodia. *Ecological Economics, 167*, 106442.
Nguyen, T. T., Nguyen, T. T., Le, V. H., Managi, S., & Grote, U. (2020b). Reported weather shocks and rural household welfare: Evidence from panel data in Northeast Thailand and Central Vietnam. *Weather and Climate Extremes, 30*, 100286.
Nguyen, T. T., Tran, V. T., Nguyen, T. T., & Grote, U. (2021). Farming efficiency, cropland rental market and income effect: Evidence from panel data for rural Central Vietnam. *European Review of Agricultural Economics, 48*(1), 207–248.
Nwosu, E. O., Anumudu, C. N., & Nnamchi, C. E. (2020). Microeconomic determinants of household savings in Nigeria. *Journal of International Development, 32*(2), 150–167.
Panman, A., Madison, I., Kimacha, N. N., & Falisse, J. B. (2022). Saving up for a rainy day? Savings groups and resilience to flooding in dar es salaam, Tanzania. *Urban Forum, 33*(1), 13–33.

Paumgarten, F., Locatelli, B., Witkowski, E. T., & Vogel, C. (2020). Prepare for the unanticipated: Portfolios of coping strategies of rural households facing diverse shocks. *Journal of Rural Studies, 80*, 91–100.
Sagemüller, F., & Mußhoff, O. (2020). Effects of household shocks on risk preferences and loss aversion: Evidence from upland smallholders of south east asia. *The Journal of Development Studies*, 1–18.
Salignac, F., Hanoteau, J., & Ramia, I. (2022). Financial resilience: A way forward towards economic development in developing countries. *Social Indicators Research*, 1–33.
Schulte, O., Nguyen, T. T., & Grote, U. (2022). The effect of renting in cropland on livelihood choices and agricultural commercialization: A case study from rural Vietnam. *The European Journal of Development Research*, 1–21.
Slijper, T., de Mey, Y., Poortvliet, P. M., & Meuwissen, M. P. (2022). Quantifying the resilience of European farms using FADN. *European Review of Agricultural Economics, 49*(1), 121–150.
Smith, L. C., & Frankenberger, T. R. (2018). Does resilience capacity reduce the negative impact of shocks on household food security? Evidence from the 2014 floods in Northern Bangladesh. *World Development, 102*, 358–376.
Tan, J., Peng, L., & Guo, S. (2020). Measuring household resilience in hazard-prone mountain areas: A capacity-based approach. *Social Indicators Research, 152*(3), 1153–1176.
Trani, J. F., Biggeri, M., & Mauro, V. (2013). The multidimensionality of child poverty: Evidence from Afghanistan. *Social Indicators Research, 112*, 391–416.
United Nations. (2005). *Designing household survey samples: Practical guidelines*. The department of Economic and Social Affairs of the United Nations (UN). UN. Retrieved June 14, 2022, from https://unstats.un.org/unsd/demographic/sources/surveys/Handbook23June05.pdf
Upton, J., Constenla-Villoslada, S., & Barrett, C. B. (2022). Caveat utilitor: A comparative assessment of resilience measurement approaches. *Journal of Development Economics, 157*, 102873.
Waibel, H., Grote, U., Min, S., Nguyen, T. T., & Praneetvatakul, S. (2020). COVID-19 in the greater Mekong Subregion: How resilient are rural households? *Food Security, 12*(4), 779–782.
WB. (2018a). *Why the World Bank is adding new ways to measure poverty. The World Bank group (WB)*. Retrieved June 14, 2022, from https://blogs.worldbank.org/developmenttalk/why-world-bank-adding-new-ways-measure-poverty
WB. (2018b). Poverty and Shared Prosperity 2018b: Piecing Together the Poverty Puzzle. The World Bank group (WB). Retrieved June 14, 2022, from https://openknowledge.worldbank.org/bitstream/handle/10986/30418/9781464813306.pdf
Wineman, A., Mason, N. M., Ochieng, J., & Kirimi, L. (2017). Weather extremes and household welfare in rural Kenya. *Food Security, 9*(2), 281–300.
Yang, B., Feldman, M. W., & Li, S. (2021a). The status of family resilience: Effects of sustainable livelihoods in Rural China. *Social Indicators Research, 153*(3), 1041–1064.
Yang, L., Lu, H., Wang, S., & Li, M. (2021b). Mobile internet use and multidimensional poverty: Evidence from a household survey in rural China. *Social Indicators Research, 158*(3), 1065–1086.
Yilma, Z., Mebratie, A., Sparrow, R., Abebaw, D., Dekker, M., Alemu, G., & Bedi, A. S. (2014). Coping with shocks in rural Ethiopia. *Journal of Development Studies, 50*(7), 1009–1024.