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Households' resilience and local commercialization in Thailand

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Abstract

Understanding households' resilience strategies under uncertainties is important in several domains including social protection, adaptation to climate change, minimizing disaster-related risks, and humanitarian aid. At the same time, food security is an important problem for developing countries, especially in places where are vulnerable to external shocks. We use the data of 1648 identical households from Thailand collected in 2010, 2013, and 2016 to examine the factors affecting households' resilience capacities and the impacts of these capacities on household consumption and crop commercialization. We employ savings per capita as households' absorptive capacity and income diversification index as households' adaptive capacity. We take into account household consumption and crop commercialization as the indicators of local food systems. Our results show that the experience of shocks in previous years positively correlates with households' saving per capita and income diversification. Further, a better absorptive capacity in the form of better savings and a better adaptive capacity in the form of higher income diversification have a significant and positive influence on household expenditure per capita and crop commercialization. Therefore, development policies and programs aiming to improve income, increase savings, and provide income diversification opportunities are strongly recommended.

Keywords: Absorptive capacity, Adaptive capacity, Crop commercialization, Panel data, Instrumental variable

JEL: C33, Q00, Q12

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1. Introduction

Understanding households' resilience is important in several domains, including social protection, adaptation to climate change, minimizing disaster-related risks, and humanitarian aid (Barrett et al., 2021). Resilience is a key concept used in many development areas, such as engineering, ecology, epidemiology, psychology, and, most popularly, social sciences. In the field of social sciences, the conceptualizations of resilience are rich and widely used to analyze the complexity of food systems in developing countries in which many people and social groups rely on fishing, farming, and agroforestry and to examine how resilient of local food systems in absorbing or adapting to different types of unexpected shocks (Béné, 2020; Smith and Frankenberger, 2018).

Food security is a serious problem for developing countries, especially in places vulnerable to external shocks. The impacts of the COVID-19 pandemic on food security are an exemplar. In addition to more than 820 million people who were already identified as chronically food insecure, the COVID-19 pandemic pushed 135 million people into crisis level or worse. These figures could nearly double at the end of 2020 due to COVID-19 (UN, 2020). The pandemic has exposed the fragility of our food security system and food sales through supermarkets, convenience stores, online platforms, and supercenters. The topic of resilience and food security has become critical in light of the disruptions of food systems caused by events such as the COVID-19 pandemic (Béné, 2020).

One might argue that the case of the COVID-19 pandemic is an extraordinary event. However, many countries, for instance, in Southeast Asia, are facing more severe and frequent weather shocks such as storms, droughts, floods, and soil erosion (Nguyen et al., 2022b; Nguyen and Nguyen, 2020). These covariate shocks reduce rural households' consumption and push them into poverty (Nguyen et al., 2020; Nguyen et al., 2022a). This shows that establishing a resilient and sustainable food system is very important since it determines the food security prospects (D'Errico et al., 2018). The vulnerable context is believed to affect households'

livelihood and resilience strategies (Ansah et al., 2019; Do et al., 2022). The question arises whether these resilience-building strategies have an impact on local household' consumption and crop commercialization.

Even though several studies exist on this topic, there are fewer studies on the effects of households' resilience strategies on the local food system, especially the commercialization of crops. Under adverse shocks, producers might pursue resilience strategies that reduce the amount of food sold in local food markets. For example, they might keep more of their production to ensure their household's food security, reducing food availability in local, national, and global food systems. Furthermore, crop commercialization is essential to accelerate rural transformation (Schulte et al., 2022). Against this background, this research aims to examine the factors affecting households' resilience capacities and the impacts of these capacities on household consumption and crop commercialization. We focus on Thailand because of several reasons. First, Thailand is one of the top rice producers and exporters (Nguyen et al., 2022b). Any changes in local food systems can affect national and global food security through exportation. Second, Thailand belongs to the group of upper-middle-income countries. However, most of its population still lives in rural areas and depends on agricultural production (Nguyen et al., 2017; Nguyen et al., 2020). Last, Thailand is located in Southeast Asia and faces many climatic risks. This country was ranked 8th amongst the ten countries most affected by climate risks between 1999 and 2018 (Eckstein et al., 2020).

The rest of this paper is structured as follows. Section 2 reviews the previous studies. Section 3 describes the study sites and data. Section 4 presents our research method. Section 5 depicts the results and discusses these key findings. Finally, Section 6 is the conclusion and some policy implications.

2. Literature review

The most popular conceptualization of resilience considers it a set of capacities (Barrett et al., 2021; Béné et al., 2012). The capacities here refer to three types: adaptive capacity, absorptive capacity, and transformative capacity (Upton et al., 2016). In this case, absorptive capacity refers to a system's capability to reduce the food system's exposure to unexpected shocks and ensure recovery from the shocks to harvest food (Upton et al., 2016). Adaptive capacity can be considered the capability to frame informed decisions to develop alternative strategies to align with changes in the external conditions that impact food security (Panpakdee and Limnirankul, 2018). Transformative capacity is a condition at the system level to change the system configuration to ensure the resilience of food systems in the long term (Barrett et al., 2021; Béné et al., 2012; Upton et al., 2016).

Concerning food production, the resilience of food systems involves a value chain perspective. For instance, under adverse shocks, producers might pursue resilience strategies that reduce the amount of food sold in the local food system, reducing food availability transacted in national and global food systems. In recent years, the associations amongst the food systems have been enhanced, further supporting in promoting resilience, emphasizing the role of farmers as the major value chain actors, ensuring the sustainable transition of food systems, and improving food security (Béné et al., 2016). From the value chain aspect, farmers are usually treated as vulnerable actors because they do not have sufficient capabilities to bargain the prices of their products (Thilmany et al., 2021). Understanding their behavior, for example, towards commercialization, is essential in the context of shocks and uncertainties.

Amongst the resilience capacities of food systems, absorptive capacity and adaptive capacity appear to be key dimensions to the security of a food system. Absorptive capacity is an important dimension of a food system to determine the capabilities of the system to handle external shocks. It supports having the suitable mechanism to enhance the persistence of system functions and implementing the latest harvesting strategies to avoid the problem of floods and

children's food security problems (FAO, 2020). The adaptive capacity measures are related to support in making the right and informed decisions to plan the alternative strategies to improve the livelihoods of people living in farming and rural areas or various key strategies such as cultivating different crops and diversification of activities related to livelihood (Ansah et al., 2019). The last capacity of the food system is the transformative capacity which refers to a complete shift of producers to a new product or even away from crop production (Slijper et al., 2022). Transformation is not widespread in developing countries since many food growers still stick to crop production. Some household members migrate from rural to urban areas due to shocks (Nguyen and Do, 2022; Nguyen et al., 2019), but this should be considered an adaption, not a transformation.

Empirical evidence shows that households' absorptive and adaptive capacity can be reflected by the amount of savings, human resources, and diversification of income and agro-portfolio (Ansah et al., 2021; Arslan et al., 2018; Birthal and Hazrana, 2019). These capacities define households' coping strategies in dealing with shocks. Although some studies have focused on households' resilience and its impacts on food security, there are other significant gaps. First, the problems of endogeneity and unobserved heterogeneity have not been well-addressed in previous studies (Haile et al., 2022). It appears that the resilience capacity of rural households can be inherited from their previous years. Using lagged indicators of resilience alone might not be adequate since resilience capacity might be correlated with other household characteristics. We contribute to the current literature by filling these methodology gaps. Second, many quantitative studies on resilience used cross-sectional data (Barrett et al., 2021), resulting in the impacts of resilience not being well assessed. In our study, we use panel data from a long-term project that can address this data issue. Last, there has been little evidence on the determinants of resilience strategies and their impacts on local food commercialization from countries in the middle-income group (Béné, 2020).

In this study, we examine the determinants of households' resilience capacity. We use savings and income diversification to capture households' adsorptive and adaptive capacity. The use of these indicators is in the same vein as that from the work of Birthal and Hazrana (2019) and Slijper et al. (2022). Next, we consider the impacts of these capacities on households' consumption and crop commercialization. Findings from our study are expected to provide helpful insight for policy-makers in developing countries to form relevant policies to improve households' resilience, food security, and rural transformation.

3. Study sites and data

3.1. Study sites and sample

The data set is obtained from the Thailand-Vietnam Socio-Economic Panel (TVSEP). This is a long-term project, namely, the *'Poverty dynamics and sustainable development: A long-term panel project in Thailand and Vietnam (TVSEP)' (DFG-FOR 756/2)* funded by the German Research Foundation (Deutsche Forschungsgemeinschaft - DFG) and managed by researchers from the Leibniz University Hanover (LUH). The TVSEP data have been collected from about 4,400 households from six provinces in Thailand and Vietnam. In Thailand, the TVSEP data operates in three provinces in the northeast region, namely Buri Ram, Ubon Ratchathani, and Nakhon Phanom (see Figure 1 for the study sites of TVSEP project in Thailand).

The sampling is based on the guidelines of the UN Department of Economic and Social Affairs (Nguyen et al., 2017; Nguyen et al., 2021). The TVSEP data include information at household and village levels. Concerning household data, the information covers a wide range of household characteristics such as demographics (members, education, health, and household dynamics), livelihood (crop production, livestock production, natural resource extraction, self-employment, and non-farm wage employment), expenditure, assets, and housing conditions. At the village level, the information includes demographic characteristics, livelihood activities,

risks and shocks, and infrastructure (detailed information about the TVSEP data can be found on the project website at www.tvsep.de). The detailed names, definitions and measurements of household and village variables used in this study can be found in Appendix 1. The final sample of our study includes 1648 identical households from Thailand collected in 2010, 2013, and 2016. Compared with the original sample collected in 2007 (2186 households), this reduced sample equals an attrition rate of 6% per wave. The main reasons for this reduction of the sample are that we use only identical households and those with complete information (those households with missing data were dropped). The final dataset has 4944 observations.

Figure 1: Study sites of the TVSEP project in Thailand (Source: Nguyen et al., 2022b)

3.2. Measurement of income diversification

The income diversification index is constructed using the Simpson diversity index, a popular measure in terms of diversity. This index can account for individuals' different

attributes, such as divergence, richness, and evenness. The calculation of income diversification following the Simpson diversity index can be expressed as follows:

$$Income\ diversification = 1 - \sum(a_i/A)^2 \quad (1)$$

In equation 1, a_i is the income of the *i*-source, and *A* is the household's total income ($A = \sum a_i$). The Simpson index ranges from zero indicating the household has only one income source, to one representing a complete diversification of income (the household has many income sources).

3.3. Descriptive statistics

Table 1 depicts the summary statistics of the data used in the estimation procedure at the household level. The average current-year savings per capita for the whole sample is PPP$ 568 (Purchasing Power Parity – PPP$ adjusted to 2005 prices). The values of savings were PPP$ 384 in 2010, PPP$ 564 in 2013, and PPP$ 754 in 2016. It shows that the current year's savings per capita have risen throughout. The income diversification index, on average, has fallen over these years. The average income diversification of the whole sample is about 0.35. This index stood at 0.38 in 2010, reduced to 0.31 (less diversification) in 2013, and increased to 0.37 in 2016. These savings and income diversification differences are significant between years (except for the savings per capita between 2013 and 2016).

The average daily per capita consumption rose for a household during the three years from PPP$ 4.7 in 2010 to PPP$ 7.2 in 2016. The average crop commercialization (the ratio of sale to total production values) for the entire sample is 44%. There was a small fluctuation in crop commercialization between 2010 and 2016, and this ratio was significant between 2010 and 2016. We can see that 28% of the households in the entire sample experienced a shock last year. The percentage remained constant at 25% in 2010 and 2013 but rose to 33% in 2016, implying more households experiencing shocks in recent years. The average age in the sample

is 59 years old. Further, about 71% of households in our sample are male-headed. Although male heads' dominance decreased between 2010 and 2016, the figure was still high at more than 60% of households in 2016.

Table 1: Descriptive summary of household characteristics

	Whole sample (n = 4944)	2010 (n = 1648)	2013 (n = 1648)	2016 (n = 1648)	Statistical test		
					2010 vs. 2013	2010 vs. 2016	2013 vs. 2016
Current year saving per capita (PPP$)	568.07 (3433.86)	384.50 (1373.36)	564.73 (1901.07)	754.97 (5460.74)	-3.12***, a	-2.67***, a	-1.34 a
Income diversification	0.35 (0.20)	0.38 (0.19)	0.31 (0.21)	0.37 (0.20)	10.49***, a	2.09**, a	-8.43***, a
Total daily per capita expenditure (PPP$)	5.87 (4.89)	4.70 (3.88)	5.68 (4.64)	7.22 (5.64)	-6.58***, a	-14.95***, a	-8.56***, a
Crop commercialization (%)	44.11 (31.43)	45.04 (30.83)	42.14 (31.86)	45.17 (31.52)	2.66***, a	-0.12 a	-2.74*** a
Experience of shocks in last year (yes = 1)	0.28 (0.45)	0.25 (0.43)	0.25 (0.43)	0.33 (0.47)	-0.12 b	-5.30***, b	-5.18***, b
Age of household head (years)	59.21 (12.17)	57.21 (12.39)	59.33 (12.19)	61.09 (11.62)	-4.94***, a	-9.27***, a	-4.26***, a
Gender of household head (male = 1)	0.71 (0.45)	0.74 (0.44)	0.71 (0.45)	0.67 (0.47)	1.76*, b	4.26***, b	2.50**, b
Household size (persons)	3.95 (1.69)	4.13 (1.72)	3.98 (1.70)	3.74 (1.63)	2.52**, a	6.62***, a	4.07***, a
Share of laborers (%)	75.34 (23.08)	70.79 (22.43)	72.08 (22.70)	83.15 (22.08)	-1.63· a	-15.94***, a	-14.20***, a
Ethnicity of head (Thai majority = 1)	0.94 (0.24)	0.94 (0.24)	0.93 (0.25)	0.94 (0.24)	0.79 b	-0.07 b	-0.86 b
Schooling years of household head (years)	4.89 (2.62)	4.76 (2.51)	4.80 (2.62)	5.10 (2.73)	-0.43 a	-3.66***, a	-3.18***, a
Mean schooling years of adult members (years)	5.83 (2.44)	6.26 (2.14)	5.82 (2.40)	5.40 (2.67)	5.48***	10.10***	4.72***
No. farm laborers (persons)	1.99 (1.13)	2.07 (1.11)	2.01 (1.14)	1.88 (1.15)	1.49 a	4.68***, a	3.16***, a
Land area (ha)	3.41 (3.57)	3.61 (3.63)	3.90 (4.23)	2.72 (2.54)	-2.14**, a	8.16***, a	9.75***, a
Asset value per capita (PPP$)	2270.43 (4482.13)	1670.85 (3409.59)	2408.29 (5100.34)	2732.14 (4697.02)	-4.88***, a	-7.42***, a	-1.90*, a

Note: Standard deviations in parentheses; [a]: Two-sample t-test; [b]: Non-parametric rank-sum test; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

The household size on average for the sample is 3.95 and has reduced over time. The share of laborers in the households on average is 75.34%. The share shows an increasing trend between 2010 and 2016. 94% of households belong to the Thai majority group. The years of schooling of household heads on average is 4.89 years and has risen over time. The mean schooling years of adult members on average is 5.83 years and interestingly shows a decreasing trend. The average number of household members engaged in farming is 1.99 for the entire sample. The number has decreased over time, implying people are shifting away from farm

activities to non-farm ones. The land area is 3.41 ha on average for the entire sample and shows a decreasing trend between 2010 and 2016. Lastly, the asset value per capita of Thai households has increased significantly between 2010 and 2016. It was PPP$ 1670 per capita in 2010, rose to PPP$ 2408 per capita in 2013, and reached PPP$ 2732 per capita in 2016.

Table 2: Descriptive summary of village characteristics

	Whole sample (n = 621)	2010 (n = 207)	2013 (n = 207)	2016 (n = 207)	Statistical test		
					2010 vs. 2013	2010 vs. 2016	2013 vs. 2016
Number of enterprises in village	0.26 (1.13)	0.10 (0.50)	0.43 (1.70)	0.26 (0.82)	-2.67$^{***, a}$	-2.33$^{**, a}$	1.33 ^{a}
Share of households having phone line at home in village	78.59 (39.71)	37.64 (46.57)	99.00 (5.42)	99.12 (4.62)	-18.83$^{***, a}$	-18.90$^{***, a}$	-0.24 ^{a}
Share of households having access to electricity in village	98.82 (5.34)	98.73 (4.13)	98.60 (7.28)	99.14 (3.95)	0.23 ^{a}	-1.04 ^{a}	-0.95 ^{a}
Share of households having cable internet at home in village	3.06 (7.52)	1.76 (4.38)	3.33 (9.91)	4.08 (7.08)	-2.09$^{**, a}$	-4.01$^{***, a}$	-0.88 ^{a}
Village has made roads (yes = 1)	0.94 (0.24)	0.89 (0.32)	0.97 (0.17)	0.96 (0.19)	-3.31$^{***, b}$	-2.82$^{***, b}$	0.54 ^{b}
Village has access to public water supply (yes = 1)	0.94 (0.24)	0.95 (0.22)	0.92 (0.28)	0.95 (0.21)	1.17 ^{b}	-0.17 ^{b}	-1.35 ^{b}
Village has bank or bank agency (yes = 1)	0.05 (0.22)	0.00 (0.00)	0.09 (0.29)	0.06 (0.23)	-4.56$^{***, b}$	-3.74$^{***, b}$	1.22 ^{b}
Travel distance to provincial capital (km)	58.48 (31.58)	57.43 (30.30)	56.48 (30.30)	61.53 (33.93)	0.32 ^{a}	-1.30 ^{a}	-1.60 ^{a}
Travel distance to the next market (km)	8.95 (7.68)	8.89 (7.87)	8.93 (7.85)	9.04 (7.34)	-0.06 ^{a}	-0.20 ^{a}	-0.15 ^{a}

Note: Standard deviations in parentheses; ^{a}: Two-sample t-test; ^{b}: Non-parametric rank-sum test; *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Table 2 summarizes the characteristics at the village level. The average number of enterprises/firms/factories in the sample is 0.26, which was the highest in 2013. The share of households having phone lines at home is 79% on average for the entire sample and has risen over the years. The share of households having access to electricity is 99% and has been the same throughout these years. The share of households having access to the internet is 3% on average. The proportion of the villages having made roads instead of dirt roads is about 94% for the whole sample. The proportion of villages with the availability of public water supply is 94% on average for the entire sample. The proportion of villages having banks in the villages on average is 5%. The travel distance to the provincial capital and the next market is about 58.5 km and 8.95 km, respectively.

4. Research method

4.1. Identifying factors affecting households' resilience capacity

To identify the determinants of households' resilience capacity, we use two indicators to reflect households' absorptive capacity and adaptive capacity. Concerning this, the "current year savings per capita" is used to denote the households' absorptive capacity, and "income diversification" is calculated from the Simpson diversity index as the adaptive capacity. The rationale behind using these indicators is that they share some similarities with the resilience indicators used in previous studies, and they also play an important role in household's coping strategies against shocks (Ansah et al., 2021; Arslan et al., 2018; Birthal and Hazrana, 2019; Dang, 2020; Slijper et al., 2022). Since we have panel data, a panel estimation with fixed effects is employed to control for the household's unobserved characteristics and specified as follows:

$$RS_{it} = \alpha_0 + \alpha_1 Shock_{it-1} + \alpha_2 Household_{it} + \alpha_3 Village_{jt} + \varepsilon_{ijt} \quad (2)$$

In equation 2, the dependent variable is RS_{it}, which represents the household's i resilience capacity at time t. As mentioned above, the RS_{it} can be (i) savings per capita or (ii) the Simpson index of income diversification. The $Shock_{it-1}$, is a dummy variable that represents the household experience with shocks (weather, demographic, or economic shocks) in the previous year. $Household_{it}$ is the vector of control variables that represent household characteristics such as the age of the household head, the gender of the household head, household size, the share of laborers, ethnicity, years of schooling at the household level, mean schooling years of adult members, number of household members engaged in farming, land area, and if the household belongs to the last 20% poorest of asset per capita. $Village_{jt}$ is a group of village's j characteristics where the household is living, namely, the number of enterprises in the villages, the share of households having phone line at home, the share of households having access to electricity, the share of households having access to the internet at home, rural situation, travel distance to the provincial capital, public water supply available, if

villages have banking services, and distance of village to the market. These household and village characteristics are widely used to examine households' livelihood strategies in developing countries (Do et al., 2022; Le et al., 2020, Nguyen et al., 2017; Nguyen et al., 2021; Obermann et al., 2020)). ε_{ijt} is the error terms.

To justify the use of fixed-effects estimations, we run two robust Hausman tests for household savings and income diversification estimations. The results of these tests, shown in Appendix 3 and Appendix 4, confirmed the appropriateness of using fixed-effects estimations. Further, the multicollinearity assumption would also be tested for the included independent variables of equation 2. We check for the problem of multicollinearity by using the Variance Inflation Factor (VIF) method. According to Hair (1995), when the VIF exceeds 10, or the tolerance is lower than 0.1, it implies a significant multicollinearity presence in the model. The results of VIF values of included independent variables of equation 2 are relatively less than 10, then multicollinearity is not present (see column (1) of Appendix 2 for the detailed VIF values). We cluster our estimation at the village level to have robust standard errors and to prevent autocorrelations.

4.2. Examining the impacts of households' resilience capacity on household's consumption and crop commercialization

In this step, we investigate the impacts of absorptive, adaptive, and transformative on household consumption and crop commercialization. The panel fixed-effects model to estimate the impacts can be written as follows:

$$Y_{it} = \beta_0 + \beta_1 RS_{it} + \beta_2 Household_{it} + \beta_3 Village_{jt} + \epsilon_{ijt} \quad (3)$$

In equation 3, Y_{it} can be (i) households' consumption per capita or (ii) their ratio of crop commercialization. These variables reflect the local food system as the higher the consumption, the higher the demand for production and the higher the commercialization, the larger the production being traded in the local system. RS_{it} is the household's resilience capacities,

namely, absorptive capacity (reflected by the saving per capita) or adaptive capacity (captured by the income diversification index). $Household_{it}$ and $Village_{jt}$ are the groups of household and village characteristics mentioned in equation 2, respectively. ϵ_{ijt} is the error term.

Since the variable RS_{it} is correlated with household's and village's characteristics as shown in equation 2, it is endogenous. We address the endogeneity problem by using the fixed effects with the instrumental variable (IV) approach. We use the rainfall data from the Tropical Rainfall Measuring Mission (TRMM), which several studies have used (for example, see Do et al., (2022)). The data consist of 17 years of daily rainfall data between 1998 and 2014. We construct the IV for our model as follows. First, we follow Jones and Hulme (1996) to generate the Standardized Rainfall Anomaly Index (SRAI) for each month from the long-term average rainfall between 1998 and 2014. Second, we create a dummy variable of a month with extreme rainfall as the SRAI is smaller than -1.0 or higher than 1.0. In the last step, we sum up the total number of months during a year with extreme rainfall. Due to the availability of the data (only until 2014), we use a lagged 2-year variable of months with extreme rainfall to instrument the RS_{it} in equation 3.

We run robust Hausman tests to check if using fixed-effects estimations is appropriate for assessing the effects of a household's resilience capacity. The results of four robust Hausman tests presented in Appendices 5 – 8 validated that the preferred models are fixed effects. We also check for the problem of multicollinearity in equation 3 using the VIF values. The results of VIF values of included independent variables of equation 3 denote that there are no signs of multicollinearity in our model (see columns (2) and (3) of Appendix 2 for the exact VIF values of household savings and income diversification model, respectively). All estimations are clustered at the village level to have robust standard errors.

5. Results and discussion

5.1. Factors affecting households' resilience capacity

Table 3 presents the factors affecting the households' resilience capacity for three models, each with dependent variables log current year savings per capita and income diversification index. We can see that the variable of last year's shock has a positive correlation with saving per capita and income diversification. These results imply that if a household experiences shock in the previous year, this household increases their saving and diversifies its income to cope with the vulnerable context in the current year. These findings are consistent with those from (Arslan et al., 2018; Nguyen et al., 2022a; Yang et al., 2021) that uncertainties positively correlate with the demand for savings and diversification. The accumulation of savings and income diversification is later used as coping strategies for rural households against shocks (Ansah et al., 2021).

The remaining significant factors at the household level include household size, ethnic majority heads, mean schooling years of adult members, number of farm laborers, land areas, and asset-poor households. One the one hand, larger and asset-poor households negatively correlate with savings accumulation. These results are reasonable since larger and asset-poor households might be unable to save a part of their income. On the other hand, households with higher mean schooling years of adult members, a higher number of members engaged in farming, and a larger land area are more likely to accumulate savings. The role of education is in the same vein as that from (Adeniyi et al., 2020; Ninh, 2021).

Table 3: The results of factors affecting households' resilience capacity from fixed-effects estimations

	Current savings per capita (ln)	Income diversification
Experience of shocks in last year†	0.224**	0.045***
	(0.087)	(0.007)
Age of household head	-0.003	0.001
	(0.007)	(0.001)
Male heads†	0.036	-0.003
	(0.190)	(0.016)
Household size	-0.125***	0.000
	(0.041)	(0.004)
Share of laborers	0.003	0.000
	(0.002)	(0.000)
Ethnic majority heads†	-0.064	0.050*
	(0.423)	(0.029)
Years of schooling of household head	0.019	0.002
	(0.033)	(0.003)
Mean schooling years of adult members	0.042*	0.004*
	(0.022)	(0.002)
No. farm laborers	0.095*	0.017***
	(0.053)	(0.005)
Land area (ha)	0.036**	-0.003*
	(0.018)	(0.002)
Asset poor†	-0.480***	0.006
	(0.121)	(0.010)
Number of enterprises in village	-0.098	-0.001
	(0.068)	(0.003)
Share of households having phone line at home in village	0.001	-0.000***
	(0.001)	(0.000)
Share of households having access to electricity in village	0.009	0.000
	(0.006)	(0.001)
Share of households having cable internet at home in village	0.001	-0.001
	(0.006)	(0.000)
Village has made roads†	0.074	-0.049***
	(0.172)	(0.016)
Village has access to public water supply†	-0.047	0.016
	(0.227)	(0.014)
Village has bank or bank agency†	0.204	0.014
	(0.170)	(0.015)
Travel distance to provincial capital	-0.003	0.001*
	(0.003)	(0.000)
Travel distance to the next market	-0.016	0.001
	(0.017)	(0.001)
_cons	3.079***	0.165*
	(0.965)	(0.086)
Number of observations	4944	4944
F(20,219)	3.50	9.69
Prob > F	0.000	0.000

Note: Standard errors clustered at village level in parentheses; †: Dummy; ln: natural logarithm; *** p<0.01, ** p<0.05, * p<0.1.

Concerning income diversification, households with a larger land area are more unlikely to diversify their income. In contrast, households with heads in the ethnic majority, higher mean schooling years of adult members, and higher number of members engaged in farming appear to be more likely to conduct income diversification. These findings on the correlations of

household characteristics with income diversification share similarities with those from Arslan et al. (2018) and Do et al. (2022). Besides, variables at the village level show that the share of households having phone lines at home and having made roads instead of dirt roads in the village have a significant and positive correlation. In contrast, travel distance to the provincial capital significantly and positively correlates with households' income diversification. These results are consistent with those from Nguyen et al. (2022a).

5.2. The impacts of resilience capacity on household consumption and crop commercialization

Table 4 shows the impacts of households' resilience capacity on household consumption and crop commercialization. It appears that a better absorptive capacity in the form of better savings and a better adaptive capacity in the form of higher income diversification have a significant and positive influence on household expenditure per capita and crop commercialization. These results imply that, with better resilience capacities, rural households are more likely to have improved welfare (higher consumption) and more likely to sell their products to contribute to national or global food security through export. Our findings shed further light on the empirical evidence of the impacts of resilience on the local food system and support the findings from D'Errico et al. (2018) and Smith and Frankenberger (2018). Furthermore, the improvement of agricultural commercialization is important since it affects the process of rural transformation (Nguyen et al., 2021; Schulte et al., 2022).

Table 4: The impacts of households' resilience capacity on household consumption and crop commercialization from fixed-effects with IV estimations

	Household consumption (ln)		Crop commercialization	
	Savings per capita (ln)	Income diversification	Savings per capita (ln)	Income diversification
Current year saving per capita (ln)	0.464***		0.102***	
	(0.126)		(0.036)	
Income diversification		5.165***		1.137***
		(1.331)		(0.427)
Age of household head	0.007**	0.001	0.000	-0.001
	(0.003)	(0.003)	(0.001)	(0.001)
Male heads†	-0.083	-0.049	-0.031	-0.024
	(0.096)	(0.087)	(0.027)	(0.027)
Household size	-0.073***	-0.134***	0.013*	-0.001
	(0.025)	(0.021)	(0.007)	(0.005)
Share of laborers	0.003**	0.004***	0.000	0.001*
	(0.001)	(0.001)	(0.000)	(0.000)
Ethnic majority heads†	0.148	-0.129	0.016	-0.045
	(0.199)	(0.191)	(0.058)	(0.042)
Years of schooling of household head	0.023	0.019	-0.002	-0.003
	(0.015)	(0.016)	(0.005)	(0.005)
Mean schooling years of adult members	-0.037***	-0.037***	-0.009**	-0.009**
	(0.011)	(0.011)	(0.003)	(0.003)
No. farm laborers	-0.042	-0.085**	-0.005	-0.015
	(0.030)	(0.034)	(0.009)	(0.010)
Land area (ha)	-0.021*	0.013	-0.001	0.006**
	(0.011)	(0.011)	(0.003)	(0.003)
Asset poor†	0.030	-0.222***	0.039	-0.017
	(0.080)	(0.061)	(0.025)	(0.018)
Number of enterprises in village	0.058*	0.022	0.009	0.001
	(0.031)	(0.018)	(0.008)	(0.004)
Share of households having phone line at home in village	0.001**	0.004***	-0.000**	0.000
	(0.000)	(0.001)	(0.000)	(0.000)
Share of households having access to electricity in village	-0.004	-0.002	-0.002	-0.001
	(0.003)	(0.004)	(0.001)	(0.001)
Share of households having cable internet at home in village	0.002	0.006**	-0.000	0.001
	(0.003)	(0.003)	(0.001)	(0.001)
Village has made roads†	0.025	0.307***	0.018	0.080**
	(0.092)	(0.111)	(0.030)	(0.033)
Village has access to public water supply†	0.003*	-0.001	-0.000	-0.001*
	(0.002)	(0.002)	(0.000)	(0.001)
Village has bank or bank agency†	0.109	0.005	0.033	0.010
	(0.122)	(0.082)	(0.034)	(0.035)
Travel distance to provincial capital	-0.096	-0.067	-0.039	-0.032
	(0.076)	(0.079)	(0.025)	(0.024)
Travel distance to the next market	0.009	-0.003	0.001	-0.002
	(0.009)	(0.005)	(0.002)	(0.002)
_cons	-0.691	-0.149	0.172	0.291*
	(0.623)	(0.567)	(0.213)	(0.174)
Number of observations	4944	4944	4944	4944
Wald chi2(20)	249.62	232.52	47.50	52.51
Prob > chi2	0.000	0.000	0.001	0.000
Weak identification test	18.171	17.077	18.171	17.077
Under identification test	0.000	0.000	0.000	0.000

Note: Standard errors clustered at village level in parentheses; †: Dummy; ln: natural logarithm; *** p<0.01, ** p<0.05, * p<0.1.

Amongst remaining significant variables, we find that household size, average schooling years of adult members, land area, number of farm laborers, and asset poor have a significant and negative effect on households' expenditure per capita, while age of heads, the share of laborers, number of enterprises in the village, the share of households having a phone line and cable internet at home in the village, having made roads and access to public water supply in village positively affect households' expenditure per capita. Further, the results show that the mean schooling year of adult members, the share of households having phone lines at home in the village, and access to public water supply in the village negatively impact households' crop commercialization. On the other hand, household size, the share of laborers, land area, and has made roads in the village appear to have a positive influence on the commercialization of crop products in rural households. To a certain extent, our land area and local infrastructure results share some similarities with the findings from Alene et al. (2008) and Schulte et al. (2022). These findings imply that larger land scales and better infrastructure facilitate the agricultural commercialization of rural households.

6. Conclusion and policy implications

Understanding households' resilience strategies under uncertainties are essential in several domains, including social protection, adaptation to climate change, minimizing disaster-related risks, and humanitarian aid. At the same time, food security is an important problem for developing countries, especially in places vulnerable to external shocks. The topic of resilience and food security has become more critical in light of the disruptions of food systems caused by events such as the COVID-19 pandemic. In this study, we employed the data of 1648 identical households from Thailand collected in 2010, 2013, and 2016 to examine the factors affecting households' resilience capacities and the impacts of these capacities on household consumption and crop commercialization. We used savings per capita and income diversification as a proxy of the household's absorptive and adaptive capacity. We considered

household consumption and crop commercialization indicators of the local food production system. We employed fixed-effects estimations with instrumental variables to address the problems of unobserved heterogeneity and endogeneity of households' resilience capacities. Our results pointed out some significant findings and implications.

First, the experience of shocks in the previous years positively correlates with households' savings per capita and income diversification. Since savings accumulation and income diversification represent households' resilience capacities, these results imply that the past experience of shocks positively drives households to increase their savings and diversify their income to cope with the vulnerable context. Therefore, supportive policies on improving income, increasing savings, and providing more opportunities for income diversification are strongly recommended in the vulnerable context in rural areas.

Second, a better absorptive capacity in the form of higher savings and a better adaptive capacity in the form of higher income diversification levels have a significant and positive influence on households' consumption per capita and crop commercialization. Last, land area and have made roads in the village appear to influence crop product commercialization in rural households positively. Hence, development policies and programs aiming at stimulating rural transformation should also consider the improvement of households' resilience capacities because better resilience influences higher crop commercialization. At the same time, agricultural commercialization is important to accelerate rural transformation. These interventions should also prioritize increasing rural households' land scale and improving local villages' transportation infrastructure (e.g., better roads).

Although our study has provided some important empirical evidence, it still has some limitations. First, the attrition rate of our reduced sample might cause concern about the results. Therefore, our results should be interpreted with care. Second, we used two single indicators to capture the resilience capacities of households that might not well reflect the practical resilience capacities of households living in rural areas. Therefore, we recommend that future studies

should employ a better measurement of household's resilience capacities, such as using the Resilience Index Measurement and Analysis framework (RIMA) and factor analysis approach to capture the resilience capacities of households.

Declaration of Competing Interest

The authors declare that they have no conflict of interest in this research.

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Appendices

Appendix 1: Variables' name, definition, and measurement

Variables	Measurement	Definition
A. Household level		
Current year saving per capita	PPP$ (adjusted to 2005 prices)	Household (accumulated) savings per capita in the current year
Income diversification	Continuous	The income diversification index varies from 0 to 1. 0 = having only one income source; 1 having many different income sources;
Total daily per capita expenditure	PPP$ (adjusted to 2005 prices)	Household daily expenditure per capita
Crop commercialization	Percentage (%)	Ratio of sale value and total production value
Age of household head	Years	Age of household head
Gender of household head	Dummy	Gender of the household head. Male household head = 1; otherwise = 0
Household size	Number of persons	Number of nucleus members in the household
Share of laborers	Percentage (%)	Share of members in working ages (from 15 to 64 years old) in the household
Ethnicity of head	Dummy	If the household members belong to Thai majority = 1; otherwise = 0
Schooling years of household head	Years	Number of schooling years of the household head
Mean schooling years of adult members	Years	Average years of schooling of adult members in the household
No. farm laborers	Number of persons	Number of members who are engaged in farming
Land area	hectares (ha)	Total land area of the household
Asset value per capita	PPP$ (adjusted to 2005 prices)	Total asset value per capita of household
Experience of shocks in last year	Dummy	If household had a shock (weather, demographic, or economic shocks) in last year = 1; otherwise = 0
B. Village level		
Number of enterprises in village	Quantity	Number of enterprises, firms, or factories in the village
Share of households having phone line at home in village	Percentage (%)	The percentage of households having phone line at home in the village
Share of households having access to electricity in village	Percentage (%)	The percentage of households having access to electricity in the village
Share of households having access to internet at home in village	Percentage (%)	The percentage of households having access to cable internet at home in the village
Village has made roads	Dummy	If made roads (instead of dirt roads) are available in the village = 1; otherwise = 0
Village has access to public water supply	Dummy	If public water supply is available in the village = 1; otherwise = 0
Village has bank or bank agency	Dummy	If bank/bank agency is available in the village = 1; otherwise = 0
Travel distance to provincial capital	Kilometer (km)	The distance from the village to the province capital
Travel distance to the next market	Kilometer (km)	The distance from the village to the next village

Appendix 2: Values of Variance Inflation Factor in the estimation of the factors affecting households' resilience capacity

	Determinants of households' resilience capacity	Impacts of resilience capacity	
		Household saving per capita	Income diversification
	(1)	(2)	(3)
Experience of shocks in last year	1.01		
Current year saving per capita		1.14	
Income diversification			1.05
Age of household head	1.28	1.28	1.28
Male heads	1.07	1.08	1.08
Household size	1.97	1.98	1.96
Share of laborers	1.50	1.50	1.49
Ethnic majority heads	1.02	1.02	1.02
Years of schooling of household head	1.37	1.38	1.37
Mean schooling years of adult members	1.24	1.25	1.25
No. farm laborers	1.79	1.79	1.80
Land area (ha)	1.10	1.12	1.10
Asset poor	1.09	1.13	1.09
Number of enterprises in village	1.03	1.03	1.03
Share of households having phone line at home in village	1.09	1.09	1.09
Share of households having access to electricity in village	1.03	1.03	1.03
Share of households having access to internet at home in village	1.10	1.10	1.10
Village has made roads	1.05	1.05	1.05
Village has access to public water supply	1.03	1.03	1.03
Village has bank or bank agency	1.06	1.06	1.06
Travel distance to provincial capital	1.08	1.08	1.08
Travel distance to the next market	1.05	1.06	1.06
Mean VIF	**1.20**	**1.21**	**1.20**

Appendix 3: The results of robust Hausman test on the estimation of the factors affecting households' resilience capacity: the case of household's savings

Test: Ho: difference in coefficients not systematic
chi2(20) = (b1-b2)' * [V_bootstrapped(b1-b2)]^(-1)*(b1-b2)
= 1633.47
Prob>chi2 = 0.0000

Appendix 4: The results of robust Hausman test on the estimation of the factors affecting households' resilience capacity: the case of household's income diversification

Test: Ho: difference in coefficients not systematic
chi2(20) = (b1-b2)' * [V_bootstrapped(b1-b2)]^(-1)*(b1-b2)
= 830.92
Prob>chi2 = 0.0000

Appendix 5: The results of robust Hausman test on the estimation of the impacts of resilience capacity on household consumption: the case of household's savings

Test: Ho: difference in coefficients not systematic
chi2(20) = (b1-b2)' * [V_bootstrapped(b1-b2)]^(-1)*(b1-b2)
= 83.74
Prob>chi2 = 0.0000

Appendix 6: The results of robust Hausman test on the estimation of the impacts of resilience capacity on household consumption: the case of household's income diversification

Test: Ho: difference in coefficients not systematic
chi2(20) = (b1-b2)' * [V_bootstrapped(b1-b2)]^(-1)*(b1-b2)
= 219.28
Prob>chi2 = 0.0000

Appendix 7: The results of robust Hausman test on the estimation of the impacts of resilience capacity on household's food commercialization: the case of household's savings

Test: Ho: difference in coefficients not systematic
chi2(20) = (b1-b2)' * [V_bootstrapped(b1-b2)]^(-1)*(b1-b2)
= 584.42
Prob>chi2 = 0.0000

Appendix 8: The results of robust Hausman test on the estimation of the impacts of resilience capacity on household's food commercialization: the case of household's income diversification

Test: Ho: difference in coefficients not systematic
chi2(20) = (b1-b2)' * [V_bootstrapped(b1-b2)]^(-1)*(b1-b2)
= 702.84
Prob>chi2 = 0.0000