Reported shocks, households' resilience and local food commercialization in Thailand

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Abstract

Purpose – The authors examine the factors affecting households' resilience capacities and the impacts of these capacities on household consumption and crop commercialization.
Design/methodology/approach – The authors use panel data of 1,648 households from Thailand collected in three years, 2010, 2013 and 2016. The authors employ an econometric model with an instrumental variable approach to address endogenous issues.
Findings – The study results show that the experience of shocks in previous years positively correlates with households' savings 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.
Practical implications – Development policies and programs aiming to improve income, increase savings and provide income diversification opportunities are strongly recommended.
Originality/value – The authors provide empirical evidence on the determinants of resilience strategies and their impacts on local food commercialization from a country in the middle-income group.

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

Paper type Research paper

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 the resilience of local food

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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 820m people who were already identified as chronically food insecure, the COVID-19 pandemic pushed 135m 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, 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 households' 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 households' 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, 2020). Last, Thailand is located in Southeast Asia and faces many climatic risks. This country was ranked 8th among the 10 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 provides 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 among 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, toward 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 policymakers 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 dataset is obtained from the Thailand Vietnam Socio-Economic Panel (TVSEP: TVSEP\tThailand Vietnam Socio Economic Panel). 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 operate 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 United Nations Department of Economic and Social Affairs (Nguyen *et al.*, 2017, 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 nonfarm 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 1,648 identical households from Thailand collected in 2010, 2013 and 2016. Compared with the original sample collected in 2007 (2,186 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 excluded). The final dataset has 4,944 observations.

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:

$$\textit{Income diversification} = 1 - \sum (a_i/A)^2 \tag{1}$$

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).

Source(s): (Nguyen *et al.*, 2022b)

Figure 1.
Study sites of the TVSEP project in Thailand

	Whole sample (n = 4,944)	2010 (n = 1,648)	2013 (n = 1,648)	2016 (n = 1,648)	Statistical test 2010 vs 2013	2010 vs 2016	2013 vs 2016
Current year savings per capita (PPP$)	568.07 (3433.86)	384.50 (1373.36)	564.73 (1901.07)	754.97 (5460.74)	−3.12***,a	−2.67***,a	−1.34a
Income diversification	0.35 (0.20)	0.38 (0.19)	0.31 (0.21)	0.37 (0.20)	10.49***,a	2.09**,a	−8.43***,a
Total daily per capita expenditure (PPP$)	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	−0.12a	−2.74***a
Experience of shocks in the last year (yes = 1)	0.28 (0.45)	0.25 (0.43)	0.25 (0.43)	0.33 (0.47)	−0.12b	−5.30***,b	−5.18***,b
Age of the 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 the 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	70.79	72.08	83.15	−1.63a	−15.94***,a	−14.20***,a
Ethnicity of the head (Thai majority = 1)	(23.08) 0.94 (0.24)	(22.43) 0.94 (0.24)	(22.70) 0.93 (0.25)	(22.08) 0.94 (0.24)	0.79b	−0.07b	−0.86b
Schooling years of the household head (years)	4.89 (2.62)	4.76 (2.51)	4.80 (2.62)	5.10 (2.73)	−0.43a	−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)	1.49a	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

Table 1.
Descriptive summary of household characteristics

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

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. 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.

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. Ninety-four percent 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 nonfarm 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$ 1,670 per capita in 2010, rose to PPP$ 2,408 per capita in 2013 and reached PPP$ 2,732 per capita in 2016.

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

	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 the 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 the 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 the 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 the 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(s): Standard deviations in parentheses; [a]: two-sample t-test; [b]: nonparametric rank-sum test; $^{***}p < 0.01$, $^{**}p < 0.05$ and $^{*}p < 0.1$

Table 2. Descriptive summary of village characteristics

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 the 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 (1) savings per capita or (2) 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, the 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 a 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 the distance between the village and 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, 2021; Obermann *et al.*, 2020). ε_{ijt} is the error term.

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 Appendixes 3 and 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 *et al.* (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, and 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. The fixed-effects estimations are carried out using the "xtreg" command in STATA.

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

In this step, we investigate the impacts of the absorptive, adaptive and transformative capacity 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 (1) households' consumption per capita or (2) 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 the 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, 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 two-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 Appendixes 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. The fixed effects with IV estimations are carried out using the "xtivreg" command in STATA.

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 savings per capita and income diversification. These results imply that if a household experiences shock in the previous year, this household increases their savings and diversifies its income to cope with the vulnerable context in the current year. These findings are consistent with

	Current savings per capita (ln)	Income diversification
Experience of shocks in the last year†	0.224**	0.045***
	(0.087)	(0.007)
Age of the 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 heads	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 the village	−0.098	−0.001
	(0.068)	(0.003)
Share of households having phone lines at home in the village	0.001	−0.000***
	(0.001)	(0.000)
Share of households having access to electricity in the village	0.009	0.000
	(0.006)	(0.001)
Share of households having cable Internet at home in the 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(s): Standard errors clustered at village level in parentheses; †: dummy; ln: natural logarithm; *** $p < 0.01$, ** $p < 0.05$ and * $p < 0.1$

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

those from Arslan *et al.* (2018), Nguyen *et al.* (2022a) and 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 a coping strategy 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, the 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 the studies of Adeniyi *et al.* (2020) and Ninh (2021).

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 a 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 the studies of 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).

Amongst remaining significant variables, we find that household size, average schooling years of adult members, land area, the 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, the 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 having 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 is essential in several domains, including social protection, adaptation to climate change, minimizing disaster-

	Household consumption (ln)		Crop commercialization	
	Savings per capita (ln)	Income diversification	Savings per capita (ln)	Income diversification
Current year savings 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 $\chi^2(20)$	249.62	232.52	47.50	52.51
Prob > χ^2	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(s): Standard errors clustered at village level in parentheses; †: dummy; ln: natural logarithm; ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$

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

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 1,648 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 IVs 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 having 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 and factor analysis approach to capture the resilience capacities of households.

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(The Appendix follows overleaf)

Appendix 1

Table A1.
Variables' name, definition and measurement

Variables	Measurement	Definition
A. Household level		
Current year savings 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 the household head	Years	Age of the household head
Gender of the 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 the head	Dummy	If the household members belong to Thai majority = 1; otherwise = 0
Schooling years of the 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 the last year	Dummy	If household had a shock (weather, demographic, or economic shocks) in the last year = 1; otherwise = 0
B. Village level		
Number of enterprises in the village	Quantity	Number of enterprises, firms or factories in the village
Share of households having phone lines at home in the village	Percentage (%)	The percentage of households having phone lines at home in the village
Share of households having access to electricity in the village	Percentage (%)	The percentage of households having access to electricity in the village
Share of households having access to Internet at home in the 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

	Determinants of households' resilience capacity (1)	Impacts of resilience capacity Household savings per capita (2)	Income diversification (3)
Experience of shocks in last year	1.01		
Current year savings 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 the village	1.03	1.03	1.03
Share of households having phone lines at home in village	1.09	1.09	1.09
Share of households having access to electricity in the village	1.03	1.03	1.03
Share of households having access to Internet at home in the 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*

Table A2. Values of variance inflation factor in the estimation of the factors affecting households' resilience capacity

Appendix 3

Test	Ho: difference in coefficients not systematic	
	$\chi^2(20)$	= (b1–b2)' * [V_bootstrapped(b1–b2)]^(−1)*(b1–b2)
		= 1633.47
	Prob > χ^2	= 0.0000

Table A3. The results of robust Hausman test on the estimation of the factors affecting households' resilience capacity: the case of household's savings

Appendix 4

Test	Ho: difference in coefficients not systematic	
	$\chi^2(20)$	= (b1–b2)' * [V_bootstrapped(b1–b2)]^(−1)*(b1–b2)
		= 830.92
	Prob > χ^2	= 0.0000

Table A4. The results of robust Hausman test on the estimation of the factors affecting households' resilience capacity: the case of household's income diversification

Appendix 5

Table A5.
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	
	$\chi^2(20)$	= (b1–b2)' * [V_bootstrapped(b1–b2)]^(−1)*(b1–b2)
		= 83.74
	Prob > χ^2	= 0.0000

Appendix 6

Table A6.
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	
	$\chi^2(20)$	= (b1–b2)' * [V_bootstrapped(b1–b2)]^(−1)*(b1–b2)
		= 219.28
	Prob > χ^2	= 0.0000

Appendix 7

Table A7.
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	
	$\chi^2(20)$	= (b1–b2)' * [V_bootstrapped(b1–b2)]^(−1)*(b1–b2)
		= 584.42
	Prob > χ^2	= 0.0000

Appendix 8

Table A8.
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	
	$\chi^2(20)$	= (b1–b2)' * [V_bootstrapped(b1–b2)]^(−1)*(b1–b2)
		= 702.84
	Prob > χ^2	= 0.0000

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