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How Do Rural Households Cope With Shocks? Evidence from Northeast Thailand

Songporne Tongruksawattana [a*], Hermann Waibel [a] and Erich Schmidt [b]

Abstract

Rural households in emerging market economies are often vulnerable to poverty due to negative shocks and limited capacity for effective ex-post coping. This study analyses the relationship between shock types and coping decisions of rural households using the panel survey data of some 2,200 households in Northeast Thailand in the context of the DFG Research Unit 756**. Empirical observations show that a large share of households suffered shocks mainly related to ecological, economic, health and social aspects. Results from a univariate probit model show that wealth status and shock severity in terms of income and asset losses encourage coping action. Regarding types of coping measure, asking for remittances from migrant household members and relatives, taking on public support programs, reallocating household resources, borrowing from formal and informal sources, using savings and selling assets are dominant. Multivariate probit model elaborates on the effect of shock types, household characteristics and location factors on the choice of coping activity. Overall, the results suggest that shocks experienced by rural households are likely to negatively affect their future welfare and more effective social risk management strategies are needed.

Keywords: shocks, coping actions, vulnerability to poverty, rural households, Thailand

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1. Introduction

Despite high rates of economic growth in emerging market economies such as Thailand disparities between the rich and the poor continue to prevail, especially in rural areas where households face high risk of falling into poverty in the future due to external shocks (ADB 2008; UNDP 2008). Understanding shocks and their consequences is essential for developing effective poverty alleviation strategies that strengthen existing coping measures. At present a better understanding of this linkage is lacking because comprehensive empirical data are rare. Therefore, this study makes use of a large-scale panel household survey to analyse the effects of common shocks on income and assets of rural households and to assess their behaviour regarding decisions to take coping action and the choice of coping measures. As part of the research project "Impact of Shocks on the Vulnerability to Poverty: Consequences for Development of Emerging Southeast Asian Economies" (DFG Research Unit 756[1]), the focus is on rural households in Thailand who primarily rely on agriculture. In particular, the paper answers the following questions:

- What types of shocks do rural households face and what are their effects on household income and asset?
- What are common ex-post shock coping measures?
- What drives households to undertake coping actions?
- What factors determine the choice of a specific coping activity?

The data for this paper are taken from a comprehensive household survey under the DFG project in three peripheral provinces in Northeast Thailand bordering to Laos and Cambodia. The provinces are Buriram, Ubon Ratchathani and Nakhon Panom. The survey targets poor rural households or those who are at risk of falling into poverty. The 3-stage cluster sampling design aims to obtain a representative sample of the target population of rural and peri-urban households (Hardeweg et al., 2007). A total of 2,183 households were initially interviewed in 2007 and the same 2,129 households were followed-up in the panel survey in 2008. To capture the major rice cropping season the surveys were conducted in April and May and covered the period from May in previous year until April in current survey year. The questionnaire contains various modules that generate information on income and consumption and other monetary and non monetary parameters related to poverty. A special module was included through which retrospective information about shock incidents that households experienced during the past 5 years was generated including the reference period for the 1st wave. In the 2nd wave only shocks that occurred during the respective reference period were included. If a household had experienced any incident causing a big problem that affected the household, the section would ask the respondent, usually the household head, to report type of shock, indicate time of occurrence and subjectively estimate the severity of the shock, e.g. high, medium, low or no impact. To measure shock severity, income and asset loss from shock in the year of occurrence were estimated. The former refers to expenditure caused by a shock and money income foregone due to

[1] DFG Research Unit 756 is a Deutsche Forschungsgemeinschaft (DFG) – collaborative research unit of the Universities of Frankfurt, Giessen, Goettingen, Hannover (all in Germany), Kasetsart University (Bangkok, Thailand) and the Centre of Agricultural Policy (Hanoi, Vietnam). For further information see http://www.vulnerability-asia.uni-hannover.de

the shock incident whereas the latter captures the value of productive and consumption assets destroyed or dispossession resulted from the shock. The covariance of the shock indicated whether other households were also affected by the same shock and the three major coping activities and the duration needed to recover from the shock were identified.

To address the research questions outlined above, a conceptual framework is introduced in the next section that allows the application of the two-period panel data collected in a rural household survey in three provinces in Northeast Thailand.

2. Conceptual framework and methodology

In the literature a distinction is made between individual household-specific (idiosyncratic) shocks such as illness and death of a household member, and covariate shocks which have an impact on a larger group of population in the same area at the same time such as weather adversity and market fluctuation (Dercon, 2002). In economic terms shocks can result in income loss or asset loss but shocks can also cause other disutility like pain, grief or depression. Since the majority of rural households engage in agricultural production, they are particularly prone to ecological shocks, e.g. drought, flooding, crop pests or livestock diseases which cause damage on agricultural output and in turn reduce income from agriculture (Tongruksawattana et al. 2008; Asiimwe and Mpuga, 2007; Pandey et al., 2007). The adverse effect of shocks is generally more severe for the poor who are less insured ex-ante against shocks and therefore are more likely to reduce consumption than wealthier households (Jalan and Ravallion, 1999). At the same time, poor rural households are more exposed to health shocks such as illness and death of a household member than wealthier households (Tongruksawattana et al. 2008; Rasmus and Lund, 2009). In some circumstances, these households are even more fragile to health shocks than to crop income shocks (Kochar, 1995).

Concerning responses to shocks, existing studies found that in their choice of coping actions households take types of shocks and household resources into account (e.g. Watts 1983 and 1988; Frankenberger 1992; Cutler 1986). The choice of coping actions also depend on household characteristics, most importantly the diversity and stability of household income sources, household assets and education of the household head (Rashid et al., 2006). For example, households compensate agricultural income loss through off-farm or non-farm employment, asset sales and borrowing (Kochar, 1999; Newhouse, 2005; Kijima et al., 2006). A study on flood and health shocks of Amazonian peasant households in Peru found that coping responses are influenced by local environmental endowments and household asset holdings (Takasaki et al., 2006). Specifically to cope with crop losses from flood, fishing effort intensification by household labour adjustment was found to be a dominant coping activity (Takasaki et al., 2010). While households with high asset levels are more likely to sell accumulated assets and use savings to cope with income loss, poor households are refrained from using savings and borrowing against assets but more likely to find work off-farm to compensate for income loss (Berloffa and Modena, 2009; Hoddinott, 2006). Recent studies also found that disposition of savings and assets, income diversification especially from off-farm

employment and informal credit help households to cope with income shortfalls as a consequence of shocks (Heltberg and Lund, 2009; Dercon, 2007). Carter and Maluccio (2002) pointed to the role of social capital as an important element of coping mechanism. However, coping options of a household are limited in a community where many households suffer from covariate shocks since mutual support from social network is restrained (Alderman and Paxson, 1992).

Assessing the choice of households to take or refrain from coping actions can be illustrated by means of a neoclassical random utility model for discrete choice decision-making (Fishburn, 1970; Manski, 1977; Greene, 2003). Facing a shock, a household has two choices, i.e. to cope or not to cope. In this context, a coping action is defined as an explicit and active undertaking to counteract the negative shock effect such as asking for remittances and public transfers, reallocating household resources, borrowing loans, drawing on savings or selling assets. On the other hand, households are categorised as "do not cope" if they respond to shocks in a passive way such as reducing consumption. The value or utility associated with coping U_1 and utility associated with not coping U_0 are index functions of deterministic and stochastic elements:

$$\text{Utility from coping:} \quad U_1 = x'\beta_1 + \varepsilon_1 \qquad \textbf{--- (1)}$$

$$\text{Utility from not coping:} \quad U_0 = x'\beta_0 + \varepsilon_0 \qquad \textbf{--- (2)}$$

Holding all other things constant, the household will make the choice that is associated with the highest utility constrained by the coping ability and possibility of the household. However, the observed choice only reveals which one provides higher utility but the magnitudes of utilities are unobserved. Therefore, the probability that U_1 is chosen, observed through the coping action $Y = 1$, is the probability that utility from coping is higher than utility from not coping and the opposite is observed for $Y = 0$ for no coping action.

$$\text{Probability to cope:} \quad \Pr\left\lfloor Y = 1 \middle| x \right\rfloor = \Pr\left[U_1 > U_0\right] \qquad \textbf{--- (3)}$$

$$\text{Probability not to cope:} \quad \Pr\left\lfloor Y = 0 \middle| x \right\rfloor = \Pr\left[U_1 \le U_0\right] \qquad \textbf{--- (4)}$$

The utility from taking a coping action can be captured as benefit from earning additional income to compensate for income and asset losses from shocks. However, a coping action also entails a cost of time, household resources and future earnings, e.g. additional off-farm employment and borrowing with interest payment.

To estimate the likelihood of coping action, a discrete choice decision-making model was developed since the choice made is qualitative with the dependent variable being an indicator of a discrete binary choice. The latent unobservable decision variable Y_i^* is assumed to be a function of some household characteristics X_i and an error term ε_i for all households i up to n (Nelson 1974; Maddala 1999).

$$Y_i^* = x_i\beta + \varepsilon_i \qquad ;i = 1,...,n. \qquad \textbf{--- (5)}$$

$$Y_{ij} = \begin{cases} 1 \text{ (cope)} & \text{if } Y_i^* = X_i\beta + \varepsilon_i > 0 \\ 0 \text{ (do not cope)} & \text{if } Y_i^* \le 0 \end{cases} \qquad ; j = 1,..., J \qquad \textbf{--- (6)}$$

The chosen coping action Y_i is observed and takes the value 1 if a coping action is taken and 0 otherwise for any given number of coping activities up to J. The response probability that a coping action is chosen depends on the parameters β which describe the impact of changes in X_i on the probability, and the covariance of error terms (Greene 2003; Pindyck and Rubinfeld 1998).

First of all, the affected household has to decide whether or not to take any coping action. For households who decide to take a coping action, the next decision is to choose which of the available and possible coping measures to take. The first step can be best analysed by a univariate binary response model. Probit and logistic regression models are usually suitable for this type of response probability analysis where the main difference is the distribution of the error term. However, the choice of the distribution for the error terms lies in the practicability of a two-step model. Because the second-step model must allow for coexistence of several different strategies for one type of shock, multivariate probit regression with a standard normal distribution is more suitable because it permits non-exclusiveness and non-exhaustiveness of the dependent choices and it relaxes the assumption of the independence of the irrelevant alternatives (IIA) assumed by the logit model (Green, 2003). The use of probit regression is becoming widely accepted in similar literature which explores the correlation between shocks and coping activities and multivariate probit is appropriate for making $J-$ different choices at a point in time where the dependent choice variables are binary (e.g. Rashid et al. 2006, Takasaki et al. 2002).

For probit model, the functional form assumes a cumulative normal distribution of the error terms.

$$\Pr(Y_{ij}=1 \mid X_i)=\Phi(\beta' X_i) \qquad \textbf{--- (7)}$$

Estimation of a univariate binary probit model is based on maximum likelihood method and the log-likelihood function for a sample of n observations is

$$\log L=\sum_{y_i=0}^{n}\log\left[1-\Phi(\beta' X_i)\right]+\sum_{y_i=1}^{n}\log\Phi(\beta' X_i) \qquad \textbf{--- (8)}$$

for observation $i=1,...,n$.

The $J-$ equation multivariate probit model takes the form of the above presented equation with an extension of the error term ε_i which now has multivariate normal distribution, each with a zero mean and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlations $\rho_{jk}=\rho_{kj}$ as off-diagonal elements to allow for correlation with each other (Cappellari & Jenkins, 2003).

$$Y_{i1}=\begin{cases}1 \text{ (coping activity 1)} & \text{if } Y_{i1}^{*}=\beta_1 X_{i1}+\varepsilon_{i1}>0\\ 0 \text{ (otherwise)} & \text{if } Y_{i1}^{*}\le 0\end{cases} \qquad \textbf{--- (9)}$$

$$Y_{i2} = \begin{cases} 1 \text{ (coping activity 2)} & \text{if } Y_{i2}^{*} = \beta_2 X_{i2} + \varepsilon_{i2} > 0 \\ 0 \text{ (otherwise)} & \text{if } Y_{i2}^{*} \leq 0 \end{cases} \quad \text{--- (10)}$$

$$Y_{iJ} = \begin{cases} 1 \text{ (coping activity J)} & \text{if } Y_{iJ}^{*} = \beta_J X_{iJ} + \varepsilon_{iJ} > 0 \\ 0 \text{ (otherwise)} & \text{if } Y_{iJ}^{*} \leq 0 \end{cases} \quad \text{--- (11)}$$

Based on the simulated maximum likelihood (SML) method, estimation of the multivariate probit model applies the Geweke-Hajivassilion-Keane (GHK) smooth recursive conditioning simulator which draws upon the product of sequentially conditioned univariate normal distribution functions with joint probability.

The decision whether or not to cope depends not only on types of shocks but also on accumulated effects of all shocks that a household faced. A household is more likely to take a coping action especially when they suffer more often from shocks and the aggregated shock severity is high. Apart from shock-related factors, household and village characteristics may also influence the capability and possibility to take a coping action and choice of a specific coping activity used in the proposed two-steps probit regression models. Once the overall decision to cope was determined by univariate probit in step 1, multivariate probit regression is carried out in step 2 to further examine the underlying correlation of the same factors on the decision to take any of the four different coping activities identified in descriptive section, i.e. 1) transfers and remittances; 2) resource reallocation; 3) borrowing; 4) using savings and selling assets.

3. Shock incidences and coping responses

For the purpose of this study, only shocks that occurred at any time between January 2006 until April 2007 for the 1st wave and shocks that occurred in May 2007 until April 2008 in the 2nd wave with at least low subjective severity were considered. More importantly, since households who experienced shock events in each survey year are not necessarily the same, two cross-section analyses of the two-period panel survey data were used to gain a better understanding and verification of shock situations and coping behaviours than a strict panel analysis which only captures the households found to have undergone shocks in both periods.

Our survey data reveal severe shock situations among rural households in Thailand as the proportion of households reported to have experienced at least one shock has increased from 32% in the 1st wave to 61% in the 2nd wave (based on Table 1). In both waves, the largest share of affected households was found in Ubon Ratchathani and the smallest in Buriram. The majority of all households experienced one to two shock events while some households reported three up to seven shocks. Furthermore, the data show the importance of agriculture in Thailand as approximately 85% of all rural households rely on agriculture as a major source of income and occupation. In this respect, an auxiliary variable of occupation is used. A household is considered to be “agricultural” if at least 25% of members report own agriculture as primary or secondary occupation. Since very few households

completely engage in agriculture and rely totally on agricultural income, the threshold allows for off-farm and non-farm employment (Tongruksawattana et al., 2008).

[Table 1: Number of households and shocks experienced]

Reported shock incidences can be categorized in four major types as summarized in Table 2. Since almost all households engage in agricultural production, ecological shocks[2] were found most dominant in both waves especially those caused by drought, flooding, heavy rainfall and crop pests. Illness and death of a household member represent the most significant health shocks with the second highest frequency of all shock incidences. Considering unfavourable political and economic situations in the country, a number of households suffered from economic shocks such as sharp increase in input prices and decrease in output prices as well as sudden job loss or business collapse. Additionally, crime and conflicts with others and social-related obligation such as spending on ceremony expenses represent another important social shock category.

[Table 2: Shock frequency, by shock type]

Shocks generally have stronger impact on income than on wealth with income loss from all shocks accounting for almost 15% of household annual income (Table 3). As most of the sudden reduction in income resulted from yield loss due to drought and flooding, ecological shocks constitute the highest income loss followed by economic, health and social shocks, respectively. On the other hand, health shocks lead to larger asset losses. Illness of a household member usually requires long-term care-taking of the patients and expensive transportation to hospitals despite waived medication costs from the social welfare. In addition, death of a household member requires funeral organisation which is an important religious and social event in Thai culture and can take place over several days or weeks. Households may then have to sell assets such as livestock and land to finance such a large ceremony.

[Table 3: Effects of shocks on household income and asset]

Table 4 gives more insight to shock experience by income and wealth per capita distribution among the surveyed households. In addition to the income indicator, wealth is an asset-based indicator reflecting aggregate value of productive and consumption assets, house, owned land, livestock and savings. For both dimensions in both survey periods, income and asset poor households are more fragile to health shocks whereas economic and social shocks are a bigger burden for households in higher income and wealth percentiles, respectively. Ecological shocks, on the other hand, appear to affect all households similarly regardless of income and wealth level.

[Table 4: Relative shock frequency, by shock type and income per capita]

[2] We use the term ecological shocks rather than agricultural shocks to capture those incidents that can as well affect non-agricultural households.

Concerning coping actions, the majority of households actively undertook at least a single measure to deal with shocks (Table 5). Observations in both periods show that health and economic shocks often received more attention to take a coping action than other shock types. In the 2nd wave, however, roughly half of all shock incidences were left "uncoped", i.e. households rather let the shocks sit in or passively responded through consumption reduction for example. For both periods, households that refrain from coping actions are mostly those that experienced ecological and social shocks.

[Table 5: Coping action by shock types (percentage of shock incidences)]

The majority of households took only one coping activity to cope with a shock although a number of households needed multiple measures simultaneously or consecutively. Common coping activities include: 1) taking up transfers and grants from public support schemes and asking for remittances from migrant members, relatives, friends and neighbours; 2) reallocating household resources such as labour and adjusting agricultural production; 3) borrowing from diverse sources; and 4) using savings and selling assets. Table 6 shows consistent patterns of coping activities in both periods. Firstly, households may receive transfers from government and public programs. In order to be eligible for public transfers, households must report reasons for application with local administrative units such as village heads. Similarly, help from friends and neighbours are available upon request. Although migrant household members or relatives may send remittances on a regular basis, households would need to address the necessity to increase the amount or ask for remittances from other relatives. Friends and neighbours are another important source of remittances both as money and in-kind. This coping activity is mostly observed for ecological and health shocks.

Alternatively, households can find additional income from off-farm and non-farm occupation by reallocate intra-household labour including temporary and permanent out-migration. In some cases children are taken out of school to work. Furthermore, household agricultural resources can be adjusted such as crop substitution and reduction of production inputs. Resource reallocation is well observed for ecological and economic shocks. To cope with social, economic and health shocks, households prefer borrowing from diverse sources. In general, to avoid a bureaucratic application process, high interest rates, collateral requirement and strict repayment schedules, households prefer informal borrowing sources, e.g. relatives, friends, neighbours, private money lenders and village funds, over formal credit institutions, such as commercial banks, Bank for Agriculture and Agricultural Cooperatives (BAAC), village banks and cooperative banks. Lastly, households can draw on savings or sell their assets such as land or livestock for a prompt and large amount of cash. Health and social shocks are usually associated with this coping measure.

[Table 6: Coping activity by shock types]

Data from our survey show that all rural households are increasingly susceptible to shocks and suffer shocks that could be related to climate changes especially flooding and drought. Health shock incidences, in particular, are more frequent among poor households while economic and social shocks are more prevalent among households with higher income and wealth. In terms of shock impacts,

ecological shocks usually result in a substantial household income reduction while health shocks deplete assets to a larger extent. However, a substantial number of households decided not to take any coping action especially to deal with ecological and social shocks. Hence, shock types seem to influence the coping action decision and induce a certain coping activity. The next section further investigates the behaviour of households and identifies the relationship between coping action decision and choice of coping activity with household, shocks and village characteristics.

4. Estimation results of coping action decision and choice of coping activity

4.1 Factors determining coping action

The estimation results of a univariate probit model predicting the implementation of a coping measure are presented in Table 7. Wealthy household are less likely to take a coping action as their wealth accumulation may provide adequate ex-ante cushion against shock and find it less necessary to search for additional off-farm occupation or to take children out of school and put them to work. Furthermore, household members currently engaging in non-agricultural sectors encourage coping action through access and information for employment opportunity while migrant household members provide reliable source of remittances. Households that can quickly reach the nearest market from the village are more likely to take a coping action than households who live further away. In rural areas, the market place is the platform for informal information exchange and social networking; hence short distance to a market supports households to increase coping opportunity. Comparison between provinces shows that households in the larger and more developed province (Ubon Ratchathani) are more likely to take a coping action than households in smaller provinces (Buriram and Nakhon Panom).

[Table 7: Univariate probit results of coping action]

Results from the model suggest that shock severity and shock type influence the likelihood that a household would take any coping action to deal with shocks as opposed to do nothing. Especially the importance of income loss from economic and health shocks as well as asset loss from health shocks were confirmed in both survey years. Income loss from social shocks and asset loss from economic shocks also show significant influence in one of the two survey years. However, the 2nd wave results indicate negative impact of income loss from ecological shocks while the opposite is observed for asset loss. The overall results imply relatively greater importance of health, economic and social shocks over ecological shocks experienced by a household. An unexpected incident of illness or death of a member poses long-term threat to the household than a sudden reduction in yield caused by flooding, drought or crop pest since the latter can be recouped in the next cropping season. However, the implication of loss to the household is multi-fold if someone falls ill or passes away. Household labour capacity is reduced either temporarily (illness) or permanently (death) and other household members must reallocate time from other productive activities to take care of the sick person or organise the funeral. With respect to economic shocks especially job loss and business collapse pose

severe threat to household income and therefore push households to take an action to compensate for the income and asset loss. Although households suffer fewer social shocks than other shock types, the income loss especially from litigation payment or ceremony expenses are substantial that drive households to act.

4.2 Factors determining choice of coping activity

Multivariate probit model further reveals specific relationships between the same set of variables from the first model and the probability that a particular coping activity is chosen with the possibility that a household may choose multiple activities to deal with the same shock (Table 8 and 9). As shown earlier, rural households generally resort to any of four major coping measures: taking public transfers and remittances, reallocating household resource, borrowing, using saving and selling assets. The results confirm the expectation from the univariate model that households with more migrant members are more likely to use remittances to cope with shock. Using savings and selling assets are found to be positively correlated to wealth per capita while the opposite direction is observed for borrowing especially in the 2nd survey year. Households with a higher level of wealth are more likely to use savings and sell assets and less likely to borrow. Higher education level of household member increases the possibility and ability to find additional off-farm or non-farm employment and to restructure agricultural production. However, households with greater reliance on agriculture as a main source of income tend to avoid using savings and selling assets that are essential to continue cropping or livestock production.

The severity and the types of shock have influence, at least to some extent level of significance, on coping activity decision and the influence of income and asset losses from different shock types is observed in diverse variations. Income loss from ecological shocks encourages resource reallocation and borrowing while households refrain from using savings or sell assets. Households whose crop was destroyed from flooding and drought are eligible to receive monetary compensation and in-kind consumables from public programs for disaster relief. However, households must go through a long application and approval procedure and the payment may be delayed up to several months after the event. Also, the amount of compensation is generally underrated proportionally to damage. Thus, households would need to borrow and earn off-farm wage to bridge the instantaneous income shortfall. But if ecological shocks destroy important assets such as a rice field infrastructure (irrigation canals, dikes) or damage property, however, households are more likely to apply for public transfers and/or ask for remittances from migrant members, relatives and friends.

Households with high income and asset loss from economic shocks would opt for borrowing but refrain from using savings as not to further deplete future household income. In this case, remittances and public transfer is not a preferred coping choice since economic shocks may also affect migrant members or friends in the same neighbourhood. Income losses from health shocks trigger households to borrow while asset loss from the same shock urges use of savings. Income loss from social shocks

encourages resource reallocation while asset losses due to the same shock calls for using savings and avoid borrowing, remittances and public transfer.

Results of village characteristics variables show the implication of travelling distance and economic institutions on coping choices. Households who live closer to the provincial capital are more likely to reallocate resource especially by finding off-farm/non-farm employment in the capital while households living further away are more likely to use savings or sell assets. When off-farm wage opportunity is limited, households who need to spend more time and cost to reach market are more likely to turn to borrowing.

[Table 8: Multivariate probit results of coping activity (1st wave)]

[Table 9: Multivariate probit results of coping activity (2nd wave)]

Overall model results indicate the influence of household characteristics where economic and demographic aspects together with shock types and severity play a role to choose a particular coping activity. Remittances and public transfers is a preferred choice for households with more members working or living in other locations. High asset losses from ecological shocks encourage the request for additional remittances and transfers while losses from economic and social shocks influence in the opposite direction. Households with higher education levels and closer distance to the provincial capital suffering from ecological and social shocks are more likely to reallocate household resources. Borrowing is the most popular coping activity for ecological, economic and health shocks especially for wealth-poor households who live in remote areas with lower access to economic infrastructure. Wealthy households, on the other hand, prefer to use savings or sell assets especially when they live further away from provincial capital. Lastly, losses from health and social shocks increase the likelihood that households would draw on savings while losses from ecological and economic shocks refrain households from further depletion of household assets.

6. Summary and conclusion

Rural households in Thailand are vulnerable to shocks and hence are at risk of falling into poverty in the future. Based on our results from a two-period panel data set of some 2200 households in three provinces in Northeast Thailand the number of households affected by shocks doubled in 2008 as compared to the 2007/2006 survey year. The data show that the majority of households rely on agriculture as a main income source and suffer most often and most severely from ecological shocks such as flooding and drought on agricultural land and crop. At the same time, health shocks especially illness and death of household members are ubiquitous events. As a result of the unfavourable political and economic situations in 2008, sharp fluctuations in prices, job loss and business collapse represent important economic shocks faced by rural households. Although less frequent, social-related events such as conflicts, crimes and ceremonies are other important types of shocks and lead to large income and asset losses. More importantly, income and asset poor households are more fragile to

health shocks while wealthy households are more prone to economic and social shocks. Ecological shocks, on the other hand, appear to similarly affect all households regardless of income and wealth level.

We found that 70% of all households actively undertook actions to cope with shocks in the first survey year while the number reduced to only 50% in the second year. Results from the univarate probit model show that the main factors that cause a household to actively respond to shocks are wealth status and the severity of the shock in terms of income and asset losses. In particular, the results imply relatively greater importance of health, economic and social shocks over ecological shocks perceived by a household. Regarding the type of coping action asking for more remittances from migrant household members and relatives, taking up opportunities for transfers from public support schemes, reallocate household resources especially labour, borrow from formal and informal sources of finance, draw on available savings and selling assets are dominant. The multivariate probit model further elaborates the effect of shock types, household characteristics and location factors on the choice of coping activity. The model results indicate an influence of the household characteristics together with types of shocks and severity. Economic and demographic aspects such as wealth status, education level, reliance on agriculture and number of migrant members living in other locations play decisive role to choose a particular coping activity. Location factors such as distance to provincial capital and market also support some coping measures especially off-farm wage employment and borrowing.

Overall, the results of this analysis suggest that shocks experienced by rural households in emerging market economies lead to losses in income and assets and therefore have implications for their vulnerability to poverty status. Hence, more effective social risk impact instruments are needed to enhance the capacity of rural households to cope with the negative effects of shocks. More attention is called for social safety nets to assist poor households living in remote areas as they are mostly affected by ecological and health shocks but their coping ability is more restricted than that of households with greater ex-ante wealth accumulation. For example, the often lengthy and complicated procedure to apply for compensation for weather related calamities from government authorities should be revised. In addition, healthcare and social insurance systems should be improved to ease the expense burden due to medical and hospital treatment, e.g. community health funds may be developed to provide support for transportation to hospital to the poor. On the other hand, precautionary measures should be provided for households with higher income and wealth level to prevent them from falling into poverty when facing economic shocks.

References

ADB (2008)
Key Indicators for Asia and the Pacific. Asian Development Bank.

Alderman, H. and Paxson, C.H. (1992)
Do the Poor Insurance? A Synthesis of the Literature on Risk and Consumption in Developing Countries. World Bank Policy Research Working Paper Series No. 1008, World Bank, Washington, DC.

Asiimwe, J.B. and P. Mpuga (2007)
Implications of Rainfall Shocks for Household Income and Consumption in Uganda. AERC Research Paper 168. African Economic Research Consortium, Nairobi.

Berloffa, G. and Modena, F. (2009)
Income Shocks, Coping Strategies, and Consumption Smoothing. An Application to Indonesian Data. Department of Economics Working Papers 0901, Department of Economics, University of Trento, Italia.

Cappellari, L. and S. P. Jenkins (2003)
Multivariate Probit Regression Using Simulated Maximum Likelihood. *The Stata Journal.* Vol. 3, No. 3, pp. 278-294.

Carter, M. R. and Maluccio, J. A. (2002)
Social capital and coping with economic shocks. FCND discussion papers 142, International Food Policy Research Institute.

Cutler, P. (1986)
The Response to Drought of Beja Famine Refugees in Sudan. *Disasters.* Vol. 10, No. 3, pp. 181-188.

Dercon, S. (2002)
Income Risk, Coping Strategies, and Safety Nets. World Bank Research Observer. Oxford University Press, Vol. 17, No. 2, pp. 141-166.

Dercon S. (2007)
Fate and Fear: Risk and Its Consequences in Africa. Oxford: Oxford University. Paper prepared for the African Economic Research Consortium.

Fishburn, P. (1970)
Utility Theory for Decision Making. Wiley and Son.

Frankenberger, T. (1992)
Indicators and Data Collection Methods for Assessing Household Food Security. In: Household Food Security: Concepts, Indicators, Measurements. A Technical Review, eds. S. Maxwell and T. Frankenberger. New York and Rome: UNICEF and IFAD.

Greene, W. H. (2003)
Econometric Analysis. Prentice Hall International Editions.

Hardeweg, B., Waibel, H., Praneetvatakul, S. and P.D. Tung (2007)
Sampling for Vulnerability to Poverty: Cost Effectiveness Versus Precision. In: Tielkes, Eric (ed): Tropentag 2007; Witzenhausen, Centre for International Rural Development, University of Kassel.

Heltberg, R., and Lund, N. (2009)
Shocks, Coping, and Outcomes for Pakistan's Poor: Health Risks Predominate. *Journal of Development Studies.* Vol. 45, No. 6, pp. 889-910.

Hoddinott, J. (2006)
Shocks and Their Consequences Across and Within Households in Rural Zimbabwe. *Journal of Development Studies.* Vol. 42, No. 2, pp. 301-321.

Jalan, J. and Ravallion, M. (1997)
Are the poor less well-insured? Evidence on vulnerability to income risk in rural China. *Journal of Development Economics*. Vol. 58, No. 1, pp. 61-81.

Kijima, Y., Matsumoto, T. and T. Yamano (2006)
Nonfarm Employment, Agricultural Shocks, and Poverty Dynamics: Evidence from Rural Uganda. *Agricultural Economics.* Vol. 35, supplement, pp. 459-467.

Kochar, A. (1995)
Explaining Household Vulnerability to Idiosyncratic Income Shocks. *The American Economic Review* . Vol. 85, No. 2, pp. 159-164.

Kochar, A. (1999)
Smoothing Consumption by Smoothing Income: Hours-of-Work Responses to Idiosyncratic agricultural Shocks in Rural India. *The Review of Economics and Statistics.* Vol. 81, No. 1, pp. 50-61.

Maddala, G. S. (1999)
Limited-Dependent and Qualitative VarIables in Econometrics. Cambridge University Press.

Manski, C.F. (1977)
The Structure of Random Utility Models. *Theory and Decision.* Vol. 8, No. 3, pp. 229-254.

Nelson, F.D. (1974)
On a General Computer Algorithm for the Analysis of Models with Limited Dependent Variables. NBER Working Paper No. 68.

Newhouse, D.L. (2005)
The Persistence of Income Shocks: Evidence from Rural Indonesia. *Review of Development Economics.* Vol. 9, No. 3, pp. 415-433.

Pandey, S., Bhandari, H., Ding, Sh., Prapertchob, P., Sharan, R., Naik, D., Taunk, S.K. and A. Sastri (2007)
Coping with Drought in Rice Farming in Asia: Insights from a Cross-country Comparative Study. *Agricultural Economics.* Vol. 37, No. 1, pp. 213-224.

Pindyck, R. S. and D. L. Rubinfeld (1998)
Econometric Models and Economic Forecasts, McGraw-Hill International Editions. 634 pp.

Rashid, D.A., Langworthy, M. and S. Aradhyula (2006)
Livelihood Shocks and Coping Strategies: An Empirical Study of Bangladesh Households. Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006

Takasaki, Y., Barham, B.L. and O.T. Coomes (2002)
Risk Coping Strategies in Tropical Forests: Flood, Health, Asset Poverty, and Natural Resource Extraction. Paper prepared for the 2nd World Congress of Environmental and Resource Economists, 23-27 June 2002, Monterey, California.

Takasaki, Y., Barham, B.L. and O.T. Coomes (2010)
Smoothing Income against Crop Flood Losses in Amazonia: Rain Forest or Rivers as a Safety Net? *Review of Development Economics.* Vol. 14, No. 1, pp. 48-63.

Tongruksawattana, T., Schmidt, E. and H. Waibel (2008)
Understanding Vulnerability to Poverty of Rural Agricultural Households in Northeastern Thailand. Tropentag, Hohenheim, 07.-09. October 2008.

UNDP (2008)
Human Development Report 2007/2008. Fighting Climate Change: Human Solidarity in a Divided World. The United Nations Development Programme.

Watts, M. (1983)
Silent Violence: Food, Famine and Peasantry in Northern Nigeria. Berkeley, CA, USA: University of California Press.

Watts, M. (1988)
Coping with the Market: Uncertainty and Food Security Among Hausa Peasants. In *Coping with Uncertainty in Food Supply,* I. De Garine and G.A. Harrison, eds., 260-290. Oxford: Clarendon Press.

Table 1: Number of households and shocks experienced

Province	1st wave (Jan 2006 - Apr 2007)			2nd wave (May 2007 - Apr 2008)		
	No. of surveyed households	No. of households with shock experience	No. of shocks	No. of surveyed households	No. of households with shock experience	No. of shocks
Buriram	796	180	205	788	443	728
Ubon Ratchathani	928	355	474	939	606	1209
Nakhon Panom	389	149	189	383	231	453
Total	**2113**	**684**	**868**	**2110**	**1280**	**2390**

Table 2: Shock frequency, by shock type

Shock type	1st wave (Jan 2006 - Apr 2007)		2nd wave (May 2007 - Apr 2008)	
	Frequency	%	Frequency	%
Ecological	**418**	**50**	**1037**	**44**
Drought	214	25	449	19
Flood / Heavy rainfall	112	13	262	11
Crop pest	52	6	206	9
Livestock disease	7	1	29	1
Property damage	31	4	35	1
Landslide, Erosion	1	-	5	-
Storm / cold	1	-	51	2
Economic	**148**	**18**	**490**	**21**
Price shock	39	5	342	15
Credit / Financial problems	67	8	39	2
Job / Business loss	35	4	77	3
Investments	1	-	10	-
Remittances stopped	6	1	22	1
Health	**214**	**25**	**590**	**25**
Illness of household member	138	16	404	17
Death of household member	64	8	42	2
Accident of household member	7	1	116	5
Birth	5	1	28	1
Social	**60**	**7**	**231**	**10**
Crime / Conflicts	17	2	50	2
Social obligation	28	3	105	4
Household member migration	7	1	14	1
Jail / Law suit	6	1	32	1
Divorce / Cheating	2	-	30	1
Total	**840**	**100**	**2348**	**100**

Table 3: Effects of shocks on household income and asset

Effects of shocks	1st wave N = 684	2nd wave N = 1280
Income loss per capita *(100 PPP$)* [a]		
Ecological shock	1.5 (3)	1.8 (5.4)
Economic shock	0.8 (3.6)	0.8 (8.1)
Health shock	0.8 (4.1)	0.4 (2.6)
Social shock	0.1 (0.9)	0.2 (1.8)
All shock	3.2 (6.0)	3.1 (10.6)
Asset loss per capita *(100 PPP$)* [a]		
Ecological shock	0.5 (3.1)	0.3 (1.8)
Economic shock	0.9 (5.3)	0.1 (1.4)
Health shock	1 (5)	0.3 (2.9)
Social shock	0.5 (3.2)	0.2 (2.3)
All shock	2.9 (8.5)	0.8 (4.7)

[a] Measured in *US$ PPP (2005)* with conversion factor for Thai Baht of 0.0600 (1st wave) and 0.0582 (2nd wave)
Note: Standard deviations are shown in brackets.

Table 4: Relative shock frequency, by shock type and income per capita

Quantile	Shock category (%)									
	Ecological		Business		Health		Social		Total	
	1st wave	2nd wave	1st wave	2nd wave	1st wave	2nd wave	1st wave	2nd wave	1st wave	2nd wave
Income per capita										
1	26	23	20	21	22	29	25	21	24	24
2	25	27	15	24	24	27	33	24	23	26
3	27	25	28	26	22	23	23	29	25	25
4	23	25	37	29	32	21	18	26	28	25
Wealth per capita										
1	23	23	29	21	28	29	25	21	25	24
2	28	27	22	24	22	27	22	24	25	26
3	27	25	24	26	24	23	20	29	25	25
4	22	25	26	29	26	21	33	26	25	25

Table 5: Coping action by shock types (percentage of shock incidences)

Type of shock	1st wave N = 868	2nd wave N = 2375
Ecological	58%	31%
Economic	80%	62%
Health	86%	70%
Social	68%	63%
Total	70%	51%

Table 6: Coping activity by shock types

Type of shock	No. of households		Remittances and transfer		Resource reallocation	
	1st wave	2nd wave	1st wave	2nd wave	1st wave	2nd wave
Egological	309	356	33%	24%	26%	29%
Economic	138	343	4%	7%	30%	46%
Health	248	494	24%	25%	4%	4%
Social	53	182	9%	24%	8%	8%
Total	748	1375	23%	20%	18%	22%
Type of shock	**No. of households**		**Borrowing**		**Use savings and sell assets**	
	1st wave	2nd wave	1st wave	2nd wave	1st wave	2nd wave
Egological	309	356	25%	16%	16%	31%
Economic	138	343	48%	22%	19%	24%
Health	248	494	32%	24%	40%	48%
Social	53	182	49%	28%	34%	40%
Total	748	1375	33%	22%	26%	36%

Table 7: Univariate probit results of coping action

	Number of obs = 684	Number of obs = 1280
	Wald chi2(19) = 29.29	Wald chi2(19) = 148.05
	Prob > chi2 = 0.0302	Prob > chi2 = 0.0000
	Pseudo R2 = 0.0780	Pseudo R2 = 0.1006
	Log pseudolikelihood = -198618.84	Log pseudolikelihood = -422698.74

Explanatory variables	1st wave (Jan 2006 - Apr 2007)				2nd wave (May 2007 - Apr 2008)			
	Coefficient	Robust Std. Err.	z-value	Marginal effect	Coefficient.	Robust Std. Err.	z-value	Marginal effect
Household characteristics								
Income per capita *(100 PPP$)*	-0.0010803	0.0032382	-0.33	-0.0002857	0.0015580	0.0014421	1.08	0.0000000
Wealth per capita *(100 PPP$)*	-0.0006821**	0.0002957	-2.31	-0.0001803	-0.0001512	0.0002861	-0.53	0.0000000
Maximum years of schooling	-0.0088952	0.0159969	-0.56	-0.0023520	-0.0026670	0.0107242	-0.25	0.0000000
Ratio of household members engaged in agriculture	0.0740527	0.2047139	0.36	0.0195807	-0.4412809***	0.1399683	-3.15	-0.0000077
Number of migrant member	0.0297169	0.0440993	0.67	0.0078576	0.051371*	0.0267963	1.92	0.0000009
Shock characteristics								
Income loss per capita *(100 PPP$)*								
Ecological shock	0.0204302	0.0208358	0.98	0.0054021	-0.015543*	0.0089668	-1.73	-0.0000003
Economic shock	0.0388922*	0.0200010	1.94	0.0102837	0.0575993**	0.0247738	2.33	0.0000010
Health shock	0.0638548*	0.0363157	1.76	0.0168842	0.0891518*	0.0480323	1.86	0.0000016
Social shock	0.7845305**	0.3840070	2.04	0.2074420	0.0509287	0.0420005	1.21	0.0000009
Asset loss per capita *(100 PPP$)*								
Ecological shock	0.0497289	0.0314788	1.58	0.0131491	0.1707414***	0.0584060	2.92	0.0000030
Economic shock	0.0355716	0.0257448	1.38	0.0094057	54.99888***	9.8230070	5.6	0.0009602
Health shock	0.1954588**	0.0792898	2.47	0.0516823	1.039415***	0.3702227	2.81	0.0000181
Social shock	0.0150711	0.0210692	0.72	0.0039850	0.0284972	0.0182419	1.56	0.0000005
Village characteristics								
Distance from village to provincial capital *(Kilometer)*	0.0006308	0.0017592	0.36	0.0001668	-0.0001025	0.0012203	-0.08	0.0000000
Travelling time to the next market *(Minutes)*	-0.0022772	0.0045107	-0.5	-0.0006021	-0.0075445**	0.0031480	-2.4	-0.0000001
Province dummy *(1=Buriram, 0 = other)*	0.0360393	0.1476694	0.24	0.0094543	-0.5028676***	0.1002298	-5.02	-0.0000150
Province dummy *(1=Nakhon Panom, 0 = other)*	0.3200989*	0.1502457	2.13	0.0775611	-0.2224453**	0.1090053	-2.04	-0.0000056
Constant	0.5075546*	0.2306668	2.2		0.7694826	0.1658298	4.64	
Observed probability	0.7509811				0.6371740			
Predicted probability	0.8177880				0.9999963			

***** significant at the 10% level, ****** significant at the 5% level and ******* significant at the 1% level

Table 8: Multivariate probit results of coping activity (1st wave)

Number of obs = 514 Prob > chi2 = 0.0000

Wald chi2(19) = 203.44 Log pseudolikelihood = -604757.72

SML, # draws = 24

1st wave (Jan 2006 - Apr 2007)	Remittance/Transfer			Resource Reallocation			Borrowing			Use saving and sell assets		
Explanatory variables	**Coefficient**	**z-value**	**Marginal effect**	**Coefficient**	**z-value**	**Marginal effect**	**Coefficient**	**z-value**	**Marginal effect**	**Coefficient**	**z-value**	**Marginal effect**
Household characteristics												
Income per capita *(100 PPP$)*	0.0021437	0.62	0.0006815	-0.0024939	-0.66	-0.0006921	-0.0050758	-1.28	-0.0019254	-0.0033707	-0.95	-0.0011858
Wealth per capita *(100 PPP$)*	-0.0003065	-0.91	-0.0000974	-0.0007051	-1.50	-0.0001957	-0.0000724	-0.22	-0.0000275	0.0003648	1.26	0.0001283
Maximum years of schooling	-0.0270300	-1.50	-0.0085935	0.0435999**	2.34	0.0120997	-0.0057510	-0.35	-0.0021815	0.0196389	1.20	0.0069090
Ratio of household members engaged in agriculture	-0.2667539	-1.24	-0.0848073	-0.2721230	-1.17	-0.0755189	0.0926041	0.46	0.0351277	0.0087487	0.04	0.0030778
Number of migrant member	0.0244043	0.50	0.0077587	-0.0869115	-1.58	-0.0241195	0.0581730	1.18	0.0220669	0.0014480	0.03	0.0005094
Shock characteristics												
Income loss per capita *(100 PPP$)*												
Ecological shock	0.0216650	1.02	0.0068878	0.1100049***	3.61	0.0305283	-0.0291576	-1.30	-0.0110604	-0.0515932**	-2.46	-0.0181507
Economic shock	-0.0869703***	-3.42	-0.0276499	0.0342422*	1.87	0.0095028	0.035409*	1.88	0.0134318	-0.0024451	-0.14	-0.0008602
Health shock	0.0172485	1.09	0.0054837	-0.0222232	-1.00	-0.0061673	0.0009625	0.08	0.0003651	0.0340615	1.63	0.0119830
Social shock	0.0136551	0.24	0.0043413	0.113646**	1.98	0.0315387	0.0275354	0.44	0.0104451	-0.0467165	-1.26	-0.0164350
Asset loss per capita *(100 PPP$)*												
Ecological shock	0.0001303	0.01	0.0000414	-0.0175727	-1.03	-0.0048767	0.0259777	1.43	0.0098542	-0.0036794	-0.27	-0.0012944
Economic shock	-0.0463222**	-2.03	-0.0147269	0.0059294	0.54	0.0016455	0.0134275	1.12	0.0050935	0.0060347	0.73	0.0021230
Health shock	0.0180053	1.25	0.0057243	-0.0493590	-1.57	-0.0136980	0.0093878	0.79	0.0035611	0.0324527**	2.53	0.0114170
Social shock	-0.0075323	-0.31	-0.0023947	-0.0433879	-1.17	-0.0120409	0.0151986	0.69	0.0057653	0.0470891***	2.89	0.0165661
Village characteristics												
Distance from village to provincial capital *(Kilometer)*	0.0021721	1.16	0.0006906	-0.0030013	-1.46	-0.0008329	0.0021902	1.28	0.0008308	-0.0010203	-0.55	-0.0003589
Travelling time to the next market *(Minutes)*	-0.0042566	-0.77	-0.0013533	0.0015930	0.33	0.0004421	-0.0000192	0.00	-0.0000073	0.0030309	0.65	0.0010663
Province dummy *(1=Buriram, 0 = other)*	-0.4361462**	-2.52	-0.1386610	-0.2892604*	-1.70	-0.0802748	0.2797856*	1.81	0.1061316	-0.1757034	-1.10	-0.0618132
Province dummy *(1=Nakhon Panom, 0 = other)*	-0.5802448***	-3.58	-0.1844733	-0.1757210	-1.02	-0.0487656	0.4278219***	2.83	0.1622865	0.2404211	1.63	0.0845811
/atrho21	-0.2403136***	-3.09	rho21	-0.235792***	-3.21							
/atrho31	-0.533516***	-6.91	rho31	-0.4880642***	-8.30							
/atrho41	-0.2578399***	-3.57	rho41	-0.252274***	-3.73							
/atrho32	-0.252485***	-3.37	rho32	-0.2472532***	-3.52							
/atrho42	-0.2344843***	-2.87	rho42	-0.2302792***	-2.98							
/atrho43	-0.4096767***	-5.71	rho43	-0.3881982***	-6.37							

Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 1.2e+06 Prob > chi2 = 0.0000

***** significant at the 10% level, ****** significant at the 5% level and ******* significant at the 1% level

Table 9: Multivariate probit results of coping activity (2nd wave)

Number of obs = 814 Prob > chi2 = 0.0000

Wald chi2(19) = 186.07 Log pseudolikelihood = -1033705.1

SML, # draws = 30

2nd wave (May 2007 - Apr 2008)	Remittance/Transfer			Resource Reallocation			Borrowing			Use saving and sell assets		
Explanatory variables	**Coefficient.**	**z-value**	**Marginal effect**	**Coefficient**	**z-value**	**Marginal effect**	**Coefficient**	**z-value**	**Marginal effect**	**Coefficient**	**z-value**	**Marginal effect**
Household characteristics												
Income per capita *(100 PPP$)*	0.0014482	0.92	0.0004723	-0.0008876	-0.67	-0.0003033	-0.0025579	-1.60	-0.0008529	0.0015481	1.08	0.0005960
Wealth per capita *(100 PPP$)*	-0.0004302	-1.26	-0.0001403	-0.0005519	-1.60	-0.0001886	-0.0015069***	-3.30	-0.0005024	0.0009822***	3.20	0.0003781
Maximum years of schooling	-0.0016186	-0.12	-0.0005279	0.0330268***	2.64	0.0112852	-0.0045897	-0.34	-0.0015303	-0.0089406	-0.72	-0.0034418
Ratio of household members engaged in agriculture	-0.1062957	-0.59	-0.0346685	0.2402825	1.39	0.0821044	0.1794469	1.00	0.0598323	-0.3224527**	-2.00	-0.1241315
Number of migrant member	0.0539947*	1.68	0.0176104	0.0142122	0.46	0.0048563	0.0152981	0.48	0.0051008	-0.0160229	-0.58	-0.0061682
Shock characteristics												
Income loss per capita *(100 PPP$)*												
Ecological shock	-0.0027958	-0.21	-0.0009119	0.0305457**	2.28	0.0104374	0.0420167***	2.72	0.0140095	-0.0120529	-0.96	-0.0046399
Economic shock	-0.0118533	-1.16	-0.0038660	0.0029444	0.76	0.0010061	0.0190562*	1.82	0.0063538	-0.0066079*	-1.88	-0.0025438
Health shock	0.0114289	0.63	0.0037276	0.0072414	0.50	0.0024744	0.0482178**	2.40	0.0160771	0.0162517	1.04	0.0062563
Social shock	0.0062568	0.33	0.0020407	0.0074692	0.40	0.0025522	0.0431744	1.33	0.0143955	-0.0241416	-1.31	-0.0092936
Asset loss per capita *(100 PPP$)*												
Ecological shock	0.0504477**	2.42	0.0164536	0.0087758	0.31	0.0029987	0.0151449	0.58	0.0050497	-0.0128572	-0.46	-0.0049495
Economic shock	-0.2458335	-1.35	-0.0801789	-0.0066832	-0.32	-0.0022836	-0.0892599	-1.55	-0.0297616	0.0755233	0.90	0.0290735
Health shock	-0.0082585	-0.59	-0.0026935	0.0058264	0.52	0.0019909	-0.0034131	-0.16	-0.0011380	0.0019070	0.16	0.0007341
Social shock	-0.1304901*	-1.85	-0.0425595	0.0097883	0.59	0.0033447	0.0512953*	2.03	0.0171032	0.0047627	0.27	0.0018334
Village characteristics												
Distance from village to provincial capital *(Kilometer)*	-0.0006308	-0.44	-0.0002057	-0.0027594*	-1.89	-0.0009429	-0.0018494	-1.23	-0.0006166	0.0025981*	1.90	0.0010002
Travelling time to the next market *(Minutes)*	-0.0064275	-1.31	-0.0020963	0.0000276	0.01	0.0000094	0.0093062**	2.30	0.0031029	-0.0032668	-0.79	-0.0012576
Province dummy *(1=Buriram, 0 = other)*	0.3294316**	2.35	0.1074446	0.2387781*	1.80	0.0815903	-0.3084787**	-2.34	-0.1028549	-0.1607598	-1.27	-0.0618861
Province dummy *(1=Nakhon Panom, 0 = other)*	-0.0179327	-0.14	-0.0058488	0.2428602*	1.85	0.0829852	-0.0072814	-0.06	-0.0024278	-0.1285775	-1.02	-0.0494972
/atrho21	-0.2991685***	-5.20	rho21	-0.2905515***	-5.52							
/atrho31	-0.2470394***	-4.21	rho31	-0.2421336***	-4.38							
/atrho41	-0.4050738***	-6.66	rho41	-0.3842819***	-7.41							
/atrho32	-0.1874927***	-3.22	rho32	-0.1853261***	-3.30							
/atrho42	-0.4249241***	-7.31	rho42	-0.4010706***	-8.22							
/atrho43	-0.190305***	-3.32	rho43	-0.1880405***	-3.40							

Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 2.1e+06 Prob > chi2 = 0.0000

***** significant at the 10% level, ****** significant at the 5% level and ******* significant at the 1% level