Response to Shocks and Risks of Rural Households in Northeast Thailand

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Referent: Prof. Dr. Hermann Waibel
Institut für Entwicklungs- und Agrarökonomik
Wirtschaftswissenschaftliche Fakultät
der Gottfried Wilhelm Leibniz Universität Hannover

Korreferent: Prof. em. Dr. Erich Schmidt
Institut für Umweltökonomik und Welthandel
Wirtschaftswissenschaftliche Fakultät
der Gottfried Wilhelm Leibniz Universität Hannover

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Zusammenfassung

Armut und Vulnerabilität sind noch immer gravierende, ungelöste sozioökonomische Probleme, die nicht nur in den ärmeren Entwicklungsländern vorherrschen, sondern auch in Schwellenländern, wie z. B. Thailand, weit verbreitet sind - trotz des dort realisierten hohen Wirtschaftswachstums und der steigenden durchschnittlichen Pro-Kopf-Einkommen. Wirtschaftlich und gesellschaftlich benachteiligt sind in diesen Ländern vor allem auch Haushalte in ländlichen, zumeist abgelegenen Regionen, in denen der Agrarsektor die Lebens- und Beschäftigungsgrundlage der Bevölkerung bildet. Das Auftreten von negativen Schocks und die ständige Bedrohung durch Risiken erschweren das Bestreben chronische Armut zu überwinden und vergrößern die Gefahr, dass Haushalte in transitorischer Armut unter die Armutsgrenze fallen. Strategien und Programme zur Armutsbekämpfung für diese Bevölkerungsgruppen sollten daher nicht nur die Bedürfnisse der gegenwärtig armen ländlichen Agrarhaushalte berücksichtigen, sondern auch die Erfordernisse der von Armut bedrohten Haushalten.

Bei der Entwicklung und Ausgestaltung effektiver politischer Maßnahmen zur Armutsbekämpfung stellt das theoretische Konzept der Vulnerabilität einen umfassenden Analyserahmen zur Erfassung und Bewertung von dynamischer Armut, welche sowohl Armut als auch Armutsgefährdung beinhaltet, zur Verfügung. In diesem Konzept werden insbesondere auch eingetretene *(ex-post-)* Schocks und zukünftige *(ex-ante-)* Risiken einschließlich der vorhandenen und angewendeten Schadensminderungsstrategien sowie die verfügbaren und ergriffenen Maßnahmen zur Gefahrenabwehr sowie Risikoprävention berücksichtigt.

Das Ziel der vorliegenden Arbeit ist es, die Phänomene der Armut und Vulnerabilität von kleineren ländlichen Agrarhaushalten im Nordosten Thailands zu analysieren. Im Mittelpunkt des Interesses stehen dabei die vorherrschende Schock- und Risikosituation einschließlich ihrer Auswirkungen auf die Einkommenslage der Haushalte sowie die von ihnen ergriffenen Maßnahmen zur *ex-post*-Schadensbegrenzung bzw. Schadensminderung und *ex-ante*-Risikovorsorge bzw. Schadensvermeidung.

Die spezifischen Ziele der Arbeit sind (vgl. Kapitel 1):

(I) Die Identifikation und Systematisierung der Schocksituation nach Schocktypen und der mit ihnen verbundenen Auswirkungen unter Einbeziehung der von den Haushalten ergriffenen Maßnahmen zur *ex-post*-Schadensbewältigung.

(II) Die Analyse der Beziehungen zwischen den Erfahrungen der Haushalte mit negativen Schocks und ihrer individuellen Wahrnehmung bzw. Einschätzung von zukünftigen Risiken am Beispiel der besonders häufigen witterungsbedingten Schocks. Aufbauend auf den Ergebnissen wird anschließend untersucht, ob und wie diese Risikowahrnehmung die *ex-ante*-Risikovorsorge beeinflusst. Im Rahmen dieses zweiten Ziels wird zusätzlich eine vergleichende Analyse zwischen Thailand und Vietnam durchgeführt, um an diesem Beispiel länderübergreifende Gemeinsamkeiten und Unterschiede aufzuzeigen.

(III) Die quantitative Analyse der Auswirkungen von ökonomischen Schocks am Beispiel der Preissteigerungen zwischen 2008 und 2009 für landwirtschaftliche Erzeugnisse (positiver Schock) und für landwirtschaftliche Produktionsfaktoren (negativer Schock) auf Armut und Vulnerabilität der ländlichen Agrarhaushalte. Diese Fragestellung wird mit Hilfe eines mathematischen Programmierungsmodells bearbeitet, das einen innovativen Ansatz in der Armutsforschung darstellt.

Die drei spezifischen Forschungsfragen werden für ländliche Haushalte in drei Provinzen im Nordosten Thailands (Buriram, Ubon Ratchathani und Nakhon Phanom) bearbeitet. In der zweiten Fragestellung wird zusätzlich eine vergleichende Analyse mit den Verhältnissen in drei Provinzen in Vietnam (Dak Lak, Ha Tinh und Thua Thien Hue) durchgeführt. Die Auswahl der jeweils drei Untersuchungsregionen und die Datenerhebung in den beiden Ländern erfolgten im Rahmen des DFG-geförderten Forschungsprojekts DFGFOR756 „Impact of Shocks on the Vulnerability to Poverty: Consequences for Development of Emerging Southeast Asian Economies"[1] (vgl. Kapitel 2). Die Haushaltsdaten wurden in den Zeiträumen April bis Mai 2007 und April bis Mai 2008 in den vorab gezielt ausgewählten jeweils drei Provinzen der beiden Länder als 3-stufige geschichtete Stichprobe mit einem Umfang von je 2,200 Haushalten erhoben, so dass ein hoher Grad an Repräsentativität erreicht wurde. Zusätzlich wurden im Mai-Juni 2008 und noch einmal im Januar 2009 vertiefende Informationen in 64 gezielt ausgewählten Haushalten der Provinz Ubon Ratchathani erhoben, um detaillierte Informationen über die verwendeten landwirtschaftlichen Produktionsprozesse sowie über das Entscheidungsverhalten der Haushalte zu gewinnen.

Die Ergebnisse der vorliegenden Arbeit werden im Anschluss an die Einführung (Kapitel 1) und die Erläuterung der Datenbasis (Kapitel 2) den drei definierten Zielsetzungen folgend in den Kapiteln 3 bis 5 vorgestellt. Sie basieren auf drei angefertigten wissenschaftlichen Beiträgen, die

[1] DFGFOR756 ist eine durch die Deutsche Forschungsgemeinschaft (DFG) finanzierte Forschergruppe der Universitäten Gießen, Göttingen, Hannover und Frankfurt, sowie der Kasetsart University in Bangkok, Thailand, und dem Centre of Agricultural Policy in Hanoi, Vietnam.
Weitere Informationen unter http://www.vulnerability-asia.uni-hannover.de oder http://www.dfg.de

bereits teilweise veröffentlicht worden sind. Anschließend wird die Arbeit anhand der Synthese in Kapitel 6 zusammengefasst und als Schlussfolgerung herangezogen.

Die komparativ statische Analyse der Schocksituation und der von den betroffenen Haushalten ergriffenen Maßnahmen (Teilziel (I)) zeigt in den beiden Panelbefragungen ein weitgehend einheitliches Gesamtbild (Kapitel 3). Viele Haushalte leiden unter den Folgen von landwirtschaftlichen Schocks, bei denen ungünstige Witterungsbedingungen (Dürre, Überschwemmungen) dominieren, gefolgt von gesundheitlichen (Krankheit, Tod), ökonomischen (Preisschwankungen, Arbeitsplatzverlust) und sozialen Schocks (Ausgaben für soziale Verpflichtungen). Überraschenderweise hat die Mehrzahl der von Schocks betroffenen Haushalte keine spezifischen Maßnahmen zur Kompensation der negativen Auswirkungen ergriffen. Zudem zeigt sich, dass bei gesundheitlichen Schocks häufiger Maßnahmen zur Milderung der Schockfolgen eingesetzt wurden als bei anderen Schockarten, und dass die Haushalte bei der Schadensminderung zumeist eigene Ressourcen herangezogen haben. Hilfe der öffentlichen Hand wurden dagegen kaum genutzt. Interessant ist, dass die von den Haushalten benannten Schocktypen mit der Höhe des Wohlstandes (gemessen am Einkommen und Vermögen) korreliert sind: während ärmere Haushalte häufiger unter gesundheitlichen Schocks leiden, berichteten Haushalte mit relativ höherem Wohlstand häufiger von ökonomischen und sozialen Schocks.

Nach diesen beschreibenden Ergebnissen wurde versucht, die Wahl der ergriffenen Maßnahmen zur Schadensminderung zu erklären. Dazu wurde die Maßnahmenwahl der Haushalte in einer Probit-Regression mit der Art und der Stärke des erlittenen Schocks, den erhobenen (insbesondere ökonomischen und demographischen) Merkmalen der Haushalte sowie spezifischen wirtschaftsgeographischen Standortfaktoren korreliert. Die Ergebnisse zeigen, dass - unabhängig von der Schockart - typischerweise Kredite aufgenommen werden, und zwar umso eher, je niedriger die Einkommen der Haushalte sind. Haushalte mit höheren Einkommen greifen dagegen umso eher auf Ersparnisse zurück oder veräußern Vermögensgegenstände, je höher ihre Einkommen sind. Zur Schadensbewältigung von landwirtschaftlichen Schocks werden zudem Maßnahmen der Selbstversicherung (z. B. Umverteilung von Ressourcen) eingesetzt, wobei die relative Bedeutung mit steigendem Bildungsniveau zunimmt. Über die Rolle der prinzipiell als wichtig angesehenen privaten und öffentlichen Transfers bei der Schadensbegrenzung konnte letztlich keine überzeugende Aussage getroffen werden, weil die betroffenen Schätzergebnisse zwischen den beiden Untersuchungsperioden nicht konsistent sind und folglich keine klare Aussage zulassen.

In Kapitel 4 werden die Beziehungen zwischen witterungsbedingter *ex-post*-Schockerfahrung und Risikowahrnehmung und - darauf aufbauend - zwischen Risikowahrnehmung und

angewandten *ex-ante*-Risikomanagementstrategien in ländlichen Haushalten Thailands und Vietnams untersucht (Teilziel II). Die Ergebnisse zeigen, dass Haushalte in beiden Ländern häufig und schwer von negativen Wetterschocks betroffen sind (insbesondere Dürre, Überschwemmungen und starker Regen) gefolgt von sozio-demographischen Schocks (hauptsächlich Erkrankungen von Haushaltsmitgliedern). Darüberhinaus erlebte ein großer Anteil der Haushalte in Thailand ökonomische Schocks (überwiegend Preisschwankungen von Produktionsinputs und –outputs) während vietnamesische Haushalte anfälliger gegenüber biologischen Schocks wie beispielsweise Schädlingsbefall von Anbaupflanzen und Erkrankungen des Viehbestandes sind. Weiterführende Analysen zeigen, dass arme Haushalte (mit einem Einkommen unterhalb der Armutsschwelle) wetterbedingten und ökonomischen Schocks in beiden Ländern wesentlich häufiger und stärker ausgesetzt sind als Haushalte mit einem Einkommen oberhalb der Armutsschwelle. Ferner wird Pessimismus hinsichtlich der subjektiven Wahrnehmung von Zukunftsrisiken durch eine große Diskrepanz zwischen den Schockerfahrungen und der Risikowahrnehmung bei einer Vielzahl insbesondere der armen untersuchten Haushalte beobachtet. In beiden Ländern ist die erwartete Häufigkeit und Schwere von Wetterrisiken am höchsten. Trotz der starken Erwartung von wetterbedingten Risiken wandte nur ein geringer Anteil der thailändischen und vietnamesischen Haushalte Maßnahmen zur *ex-ante*-Risikoprävention an. Für diejenigen, die *ex-ante*-Risikovermeidungsstrategien umsetzen, sind kollektive Handlungen mit anderen Betroffenen zur Verbesserung der Infrastruktur und Investitionen zur Verbesserung der Sicherheit von Heimstätten, wie zum Beispiel der Bau von Deichen gegen Hochwasser, in beiden Ländern üblich. Individuelle Einkommensdiversifizierung und Ersparnisbildung bzw. der Aufbau von Vorräten und Sicherheitskapital werden ergänzend von thailändischen Haushalten eingesetzt. Grundsätzlich treffen in Thailand ärmere Haushalte häufiger Risikovorsorge, während in Vietnam eher Haushalte mit Einkommen über der Armutsschwelle Risikoprävention betreiben.

Danach wurde versucht, den Einfluss der subjektiven Risikowahrnehmung auf die Wahl der eingesetzten Maßnahmen zur Risikovorsorge zu erklären. Die OLS-Regressionsergebnisse zeigen, dass Schockerfahrungen auf die subjektive Wahrnehmung von Risiken übertragen werden. Andere Faktoren wie z. B. der Armutsstatus (relativ zur Armutsschwelle), landwirtschaftliche Beschäftigung, Mitgliedschaften in sozio-politischen Organisationen und das Alter des Befragten sowie Standortfaktoren können ebenfalls als signifikante positive Determinanten der wetterbedingten Risikowahrnehmung identifiziert werden. Insbesondere konnte anhand der Standard-Probit-Regression nachgewiesen werden, dass die Wahrscheinlichkeit für den Einsatz von *ex-ante*-Risikoprävention mit steigender Risikowahrnehmung in beiden Ländern zunimmt. Andererseits sinkt die Einsatzwahrscheinlichkeit von *ex-ante*-Risikovorsorge bei thailändischen Haushalten mit

steigendem Einkommensniveau. Für vietnamesische Haushalte sind Standortfaktoren, ethnische Herkunft und außerlandwirtschaftliche Beschäftigung wichtige Determinanten der Risikovorsorge. Im Vergleich zu den Haushalten in der Provinz Ha Tinh weisen die Haushalte in der Provinz Dak Lak eine wesentlich geringere Wahrscheinlichkeit für das Betreiben von Risikovorsorgemaßnahmen auf. Die Haushalte, die zu der ethnischen Mehrheit Kinh gehören, zeigen tendenziell eine höhere Einsatzwahrscheinlichkeit für Risikovorsogemaßnahmen als die ethnische Minderheit. Dagegen nimmt die Einsatzwahrscheinlichkeit für Risikoprävention mit der Einkommensdiversifizierung von außerlandwirtschaftlichen Tätigkeiten ab. In der bivariaten- (Vietnam) und multivariaten- (Thailand) Probit-Regression konnte in beiden Ländern außerdem nachgewiesen werden, dass eine ausgeprägtere Risikowahrnehmung die Wahrscheinlichkeit für eine kollektive Risikovorsorge erhöht. Darüber hinaus ist für Thailand ein positiver Einfluss der Wahrnehmung von Wetterrisiken auf die Einkommensdiversifizierung statistisch gesichert nachweisbar. Das Einkommensniveau und das Ausmaß der landwirtschaftlichen Beschäftigung können des Weiteren als signifikante Determinanten von Investitionsaktivitäten festgestellt werden, wohingegen die Ersparnisbildung signifikant vom Armutsstatus, der landwirtschaftlichen sowie außerlandwirtschaftlichen Beschäftigung von Haushaltsmitgliedern beeinflusst wird. In Vietnam sind Vermögenswerte, Landfläche und Standortfaktoren, d.h. eine gute Anbindung an Agglomerationen, als wichtigste Faktoren für kollektive Handlungen und Investitionsaktivitäten zu benennen.

Kapitel 5 behandelt das dritte Teilziel der Arbeit. Angeregt durch die außergewöhnlichen Preissteigerungen für Agrarprodukte und Produktionsfaktoren an den Welt- und nationalen Märkten im Jahre 2008 wurden die Auswirkungen der Preisschocks auf die Einkommenssituation der landwirtschaftlichen Haushalte in Thailand analysiert[2]. Das gleichzeitige Auftreten von Agrarpreissteigerungen (positiven Schocks) und Faktorpreissteigerungen (negativen Schocks) erfordert allerdings einen methodischen Ansatz, der in der Lage ist, die gegenläufigen Effekte auf das komplexe landwirtschaftliche Produktionsprogramm, die Auswirkungen auf die inner- und außerlandwirtschaftliche Beschäftigung und damit letztlich auf die Einkommenssituation der landwirtschaftlichen Haushalte abzubilden. Gleichzeitig sollte dem Problem der Risikosituation Rechnung getragen werden, denn eine "risikolose" Produktionsplanung kann keine optimale Entscheidungsgrundlage darstellen. Das zur Lösung des Problems gewählte mathematische Programmierungsmodell (Target MOTAD) kann die genannten methodischen Anforderungen erfüllen. Die zur Anwendung des Modells notwendigen Informationen, insbesondere auch über die landwirtschaftlichen Input-Output-Verhältnisse, sind im Rahmen der vertiefenden Zusatzerhebung in der Provinz Ubon Ratchathani erhoben worden. Auf der Basis der

[2] Für Vietnam wurde eine vergleichbare Analyse durchgeführt (vgl. Völker 2010).

gewonnenen Daten wurden acht verschiedene Gruppen nach dem Konzept "typischer Betriebe" definiert. Davon wurde ein Betriebstyp für die Modellierung ausgewählt, der als "ländlicher Agrarhaushalt mit hauptsächlich landwirtschaftlicher Beschäftigung in Ackerbau und Viehzucht und hohem landwirtschaftlichem Einkommensanteil" beschrieben werden kann. Mit dem mathematischen Programmierungsmodell wird zunächst versucht, die Ausgangssituation vor Preisänderung abzubilden und die Reaktionsmöglichkeiten auf die eingetretenen Preisschocks zu simulieren. Zudem wurden witterungsbedingte Risiken auf der Grundlage der umfassenden Panelerhebung als endogene Einflussfaktoren modelliert. Die Anwendung des Target MOTAD Modells hat den Vorteil, ökonomische und wetterbedingte Schocks, eine hohe Korrelation zwischen Output- und Inputpreisen sowie Allokationseffekte von Preisschocks in einem konsistenten theoretischen Rahmen einzubeziehen. Dies ermöglicht eine direkte Abbildung von Verhaltensanpassungen an veränderte Rahmenbedingungen. Mit Hilfe des Target MOTAD Ansatzes konnte zudem risikoaverses Verhalten der Wirtschaftssubjekte, das unter ländlichen Agrarhaushalten in der Untersuchungsregion empirisch bedeutsam ist, berücksichtigt werden.

Obwohl von der Preiserhöhung für landwirtschaftliche Erzeugnisse c.p. eine zunehmende Produktionsintensität erwartet werden kann, zeigen die Simulationsergebnisse, dass die Haushalte von der Erhöhung der Outputpreise nicht profitieren können. Der Grund liegt einerseits in den ebenfalls gestiegenen Faktorpreisen, die den positiven Effekt der Outputpreiserhöhung überkompensierten. Dadurch sank der Gewinn aus landwirtschaftlicher Beschäftigung (der landwirtschaftliche Lohnsatz), und die außerlandwirtschaftliche Beschäftigung wurde relativ attraktiver, weil der außerlandwirtschaftliche Lohnsatz im Modell konstant gehalten wurde. Infolgedessen wurden Arbeitskräfte aus der Landwirtschaft abgezogen und im außerlandwirtschaftlichen Bereich eingesetzt. Insgesamt ist aufgrund der Modellergebnisse festzuhalten, dass thailändische Agrarhaushalte auf die Produkt- und Faktorpreisschocks, nicht mit einer Ausweitung der Agrarproduktion durch Erweiterung der Anbaufläche für die marktbegünstigte Ernte und vermehrten Arbeitseinsatz reagiert haben, sondern im Gegenteil die Produktion marktgängiger Erzeugnisse (Jasminreis und Cassava) reduzierten und die frei werdenden Arbeitskräfte außerhalb der Landwirtschaft einsetzten. Dagegen wurden Klebreis und Gemüse zur Sicherung der Ernährung der Familie (Subsistenz) unverändert beibehalten. Insgesamt gesehen resultiert daraus trotz optimaler Anpassung des typischen Haushalts an die neue Preissituation von 2008 eine Verminderung des erwarteten Haushaltseinkommens. Gleichzeitig sinkt aber infolge der Ausweitung der außerlandwirtschaftlichen Beschäftigung die Varianz des Einkommens. Dadurch sinkt andererseits (für Haushalte, deren Gesamteinkommen über der Armutsschwelle liegt) die Wahrscheinlichkeit, unter die ländliche Armutsschwelle zu fallen von 57% auf 33%. Dies bewirkt wiederum einen tendenziellen Rückgang der Vulnerabilität. Das Ausmaß der

Verringerung der Vulnerabilität hängt aber letztlich von der Verfügbarkeit von außerlandwirtschaftlichen Beschäftigungsmöglichkeiten ab.

Im Gegensatz zu den statischen Armutsmessungen wie sie gegenwärtig noch verbreitet vorgenommen werden, verdeutlicht das Konzept der Vulnerabilität, dass Armut als dynamisches Problem verstanden werden muss, welches durch die Wechselwirkungen zwischen Schocks und Risiken verschärft wird. Insgesamt bestätigen die Ergebnisse der vorliegenden Forschungsarbeit die Existenz und die Bedeutung der Armut und der Armutsgefährdung von ländlichen Haushalten in Thailand, wie sie auch aus anderen Schwellenländern belegt ist. Insbesondere werden in dieser Forschungsarbeit eine umfassende Analyse der Vulnerabilität zur Armut von ländlichen Haushalten in Thailand hervorgehoben sowie alternative Methoden zur Bewertung von Vulnerabilität vorgestellt. In den Untersuchungperioden haben die betrachteten Haushalte Schocks aus allen vier gebildeten Gruppen erlitten (witterungsbedingte, gesundheitliche, ökonomische, soziale Schocks). Bei der Schadensminderung sind die Haushalte zumeist auf eigene Ressourcen angewiesen, wobei ärmere Haushalte weniger Optionen zur Schadenbeseitigung haben. Beim Einsatz von *ex-ante*-Managementstrategien gegen witterungsbedingte Risiken spielt die Risikowahrnehmung, die durch *ex-post*-Schockerfahrung zu erklären ist, eine bedeutende Rolle. Anhand des mathematischen Programmierungsmodells für einen typischen landwirtschaftlichen Betrieb in der Untersuchungsregion wurde gezeigt, dass dieser - entgegen der Vermutung - nicht von der beobachteten Erhöhung der Outputpreise im Jahre 2008 profitieren kann, weil die Faktorpreise gleichzeitig gestiegen waren und die Effekte der Produktpreiserhöhung tendenziell überkompensiert haben. Insgesamt lassen die Ergebnisse der vorliegenden Forschungsarbeit den Schluss zu, dass effektives soziales Risikomanagement sowie Maßnahmen zur Armutsbekämpfung unterschiedliche Typen von Haushalten, Schocks sowie Risiken voraussetzen müssen, um die verschiedenen Arten von *ex-post*-Schockbewältigungs- und *ex-ante*-Risikomilderungsstrategien gezielt zu fördern.

Schlagworte: Schocks, Risiken, landwirtschaftliche Haushalte, Thailand

Abstract

To this day, poverty and vulnerability remain grave socio-economic problems not only in poor developing countries but also in emerging market economies such as Thailand - despite high rates of economic growth and rising per capita income. Although agriculture has always been the underlying engine of economic growth as a major source of rural livelihoods, domestic food supply, employment and export earnings, most rural farm households still belong to the economic and social deprived group compared to the total population. The presence of shocks and risks constantly faced by rural farm households prolongs the spell of chronic poverty and hinders the effort to overcome transient poverty. This is the reason why the agricultural sector is one of the main targets to tackle poverty, and poverty reduction strategies and programs need to take into account not only the currently poor rural farm households but also those vulnerable households at risk to be poor in the future. In order to facilitate effective poverty alleviation development policy, the concept of vulnerability to poverty provides a comprehensive assessment of dynamic poverty taking into account the significant influence of *ex-post* shocks and *ex-ante* risks as well as *ex-post* coping actions and *ex-ante* mitigation strategies.

The overall aim of this research study is to analyze the phenomena of poverty and vulnerability among small-scale agricultural-dependent households living in rural areas in Northeast Thailand. The focus of attention lies is to assess the nature and effects of common shocks and risks on households' income situation including respective *ex-post* shock coping and *ex-ante* risk mitigation strategies.

The specific research objectives of the thesis are (see chapter 1):

(I) To identify and classify types and effects of shocks and to analyze *ex-post* coping behavior of the households.

(II) To assess the influence of negative past weather-related shock experience on the individual subjective weather risk perception, and to explore how such perception influences households' behavior regarding the choice of *ex-ante* mitigation strategies. Within this specific objective, an additional comparison between Thailand and Vietnam is conducted to identify cross-country similarities and differences.

(III) To analyze the impact of economic shocks on poverty and vulnerability of rural farm households with an example of the increase in agricultural output prices (positive shock) and input factor prices (negative shock) in 2008. For this specific objective, a new approach based on mathematical programming model, which is an innovative approach in the vulnerability research, is developed and applied to simulate the

adjustment of production activity and income-generating portfolio and the resulting vulnerability level of typical farm households.

The focus of the research objectives presented is drawn upon rural households in Ubon Ratchathani, Buriram and Nakhon Phanom provinces in Northeast Thailand. For the second specific research objective an additional cross-country conclusion with rural households in three provinces in Vietnam (Dak Lak, Ha Tinh and Thua Thien Hue) is presented. The study uses primary household data collected in the two-period panel base survey conducted in April-May 2007 and April-May 2008 in Thailand and Vietnam as part of the DFGFOR756 research project "Impact of Shocks on the Vulnerability to Poverty: Consequences for Development of Emerging Southeast Asian Economies"[3] (see chapter 2). A 3-stage stratified cluster sampling approach was used to identify a total of 2,200 representative households in three provinces in Thailand and Vietnam respectively. In addition, complementary data was collected in an in-depth panel survey conducted in May-June 2008 and January 2009 among a sub-sample of 64 households in Ubon Ratchathani province in order to capture technical production processes typical for the research area as well as specific constraints that influence the decision making behavior of these households.

Corresponding to respective specific research objectives, the thesis is presented, following the introduction (chapter 1) and the description of study area and data collection (chapter 2), as a series of three individual papers which are partly published (chapters 3 to 5) and concluded with a synthesis (chapter 6).

In chapter 3, a comparative static analysis of the two-period panel surveys shows a consistent pattern of shock-coping situations in the study area (specific research objective (I)). A large number of rural households frequently suffered from weather-related agricultural shocks especially drought and flooding, health shocks (e.g. illness and death of household members), economic shocks (e.g. price fluctuations, job loss and business collapse), and social shocks (e.g. social obligation expenses). Most remarkably, the majority of shock-affected households did not take any coping action, and in case of coping, it is more likely for health-related events as compared to other shock types. However, the current situation reveals that households are usually left alone to deal with shocks using their own available resources and the public supports are rarely used. Furthermore, reported shock types correlate with the level of well-being of the households as measured in income and asset: poorer households are found to be more susceptible to health shocks while wealthier households are more prone to economic and social shocks.

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[3] DFGFOR756 is a Deutsche Forschungsgemeinschaft (DFG)-financed collaborative research unit of the Universities of Giessen, Goettingen, Frankfurt, 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 or http://www.dfg.de

Based on these results, probit regressions are further applied to identify significant relationships between the decision to take a coping action including choice of coping measures on the one hand, and shock types, shock severity, household characteristics (especially economic and demographic situations) and location conditions on the other hand. The regression results show that, regardless of shock types, borrowing was found to be the major *ex-post* coping measure especially among lower-income households while households with higher income prefer using savings and selling assets. Additionally, self-insurance measures such as reallocation of household resources play a prominent role to deal with agricultural shocks, especially among households with higher education level. However, no conclusion can be made about the role of private remittances and public transfers because the coefficients in the probit models are not consistent between the two periods.

In chapter 4, the relationship between past shock experience, risk perception and the use of *ex-ante* risk management strategies with regards to weather risk among rural households in Thailand and Vietnam are explored (specific research objective (II)). Results indicated that households in both countries are most frequently and severely affected by adverse weather shocks (especially drought, flooding and heavy rainfall) followed by socio-demographic shocks (mainly illness of household members). Furthermore, a large share of households in Thailand experienced economic shocks especially price fluctuations of production inputs and outputs, whereas Vietnamese households are more prone to biological shocks, such as crop pests and livestock diseases. In particular, results in both countries show that poor households (income below poverty line) are exposed to weather and economic shocks substantially more than the non-poor (income above poverty line). Furthermore, pessimism with regards to subjective perception of respective future risk is observed through a large discrepancy between shock experience and risk expectation in terms of share of households expecting future risk and the anticipated frequency and severity of risk, especially among poor households. In both countries the expected frequency and severity of risks is highest for weather events. Despite vast anticipation of weather risk, only a small fraction of Thai and Vietnamese households applied respective precautionary measures. For those who undertake *ex-ante* weather risk mitigation strategies, collective action to improve infrastructure and manage common property resources as well as investment activity for homestead security are most common in both countries, whereas income portfolio adjustment through farm production and income diversification as well as savings accumulation are additionally applied by Thai households. For every strategy, *ex-ante* mitigation action is used by poor households more often than non-poor households in Thailand whereas the opposite relationship is found in Vietnam.

Using regression models, the influence of subjective risk perception, among other factors, on the application of risk management strategies is assessed. Results from OLS regression show that

past weather shock experiences are translated into subjective weather risk perception of future events while other factors such as poverty status (below income poverty line), agricultural occupation, membership in socio-political organization and age of the respondent as well as location factors are also identified as significant positive determinants of weather risk formulation. In both countries, results of the standard probit regression show that the probability to apply any *ex-ante* weather risk management strategies increases with increasing weather risk perception. On the other hand, the probability of *ex-ante* weather risk mitigation decreases with increasing income level of Thai households. For Vietnamese households, location factors, ethnicity and off-farm employment are important *ex-ante* weather risk mitigation determinants. The probability to apply *ex-ante* risk preventive measures is significantly lower for households living in Dak Lak province than in the province Ha Tinh. Households that belong to ethnic Kinh majority are more likely to apply risk prevention than the ethnic minority. In contrast higher degree of income source diversification through off-farm employment decreases the likelihood that *ex-ante* weather risk management is applied. Bivariate- (Vietnam) and multivariate- (Thailand) probit regressions further identified the likelihood to engage in collective action to increase with rising risk perception in both countries. In Thailand, similar significant positive influence of weather risk perception is found for income portfolio adjustment while no such link is found with regards to the decision to invest and accumulate savings. Income level and the degree of agricultural engagement can be further identified as significant determinants of investment activity while savings accumulation is significantly influenced by poverty status, engagement in agriculture and off-farm employment of household members. In Vietnam, asset values, land size and location factors stand out as the most important factors for collective action and investment activity.

In chapter 5, motivated by the exceptional price hike for agricultural outputs and production inputs in global and national markets in 2008, the impact of output and input price shocks on the vulnerability to poverty of a certain typical farm is assessed (specific research objective (III))[4]. The assessment of the simultaneous increase in agricultural outputs (positive shock) and production factors (negative shock) requires a methodological approach that can incorporate the contrary effects into the complex farm production planning and to simulate the impact on on-farm and off-farm activities and the resulting income situation of farm households. At the same time endogenous risk situation should also be taken into account in order to reflect the optimal basis for farm households' decision-making. Comply with such methodological requirements, an alternative approach based on mathematical programming (Target MOTAD) model is developed and applied in this framework. The necessary information required to construct attributes of the typical farm in focus, in particular the input-output relations, are

[4] A similar analysis was conducted for Vietnam (see Völker 2010).

derived from the additional in-depth survey of 64 sub-sample households in Ubon Ratchathani province. Based on the data collected, 8 groups of "typical farms" are identified, of which one group is chosen for the modeling. This group can be described as "rural farm households that primarily rely on agriculture for income and employment and operate on a dual farm system of cropping and livestock". The mathematical programming model demonstrates optimization behaviour of households' agricultural and other income-generating portfolios as a response to exogenous price shocks while facing endogenous weather risks, agricultural production pattern and household resource constraints. The application of Target MOTAD model has advantage to incorporate economic and weather shocks, high correlation between output and input prices, as well as allocation effects of the price shocks in a theoretically consistent framework and allowing direct observation of behavioral adjustment when the underlying condition is modified. The incorporation of risk through the Target MOTAD approach is a plausible representation of the degree of risk aversion which is empirically evident among rural farm households in the study area.

Although farm households, all else equal, are expected to respond to the output price increase by cash-crop intensification, simulation results reveal that household cannot profit from the output price increase due to the simultaneous rising of input price (negative shock) that crowds out the positive price effect. On the other hand, on-farm household labour is shifted to off-farm employment as a result of lower gross margin from agriculture whereas off-farm wage income (held constant in the model as in the base scenario) became relatively more attractive to on-farm earnings. By and large it can be observed that Thai farm households responded to output and input price shocks by reducing the cropping area for cassava and jasmine rice, the two commercial crops, while the glutinous rice and backyard vegetable cultivation remained unchanged for subsistence consumption. Given the price level in 2008, optimal adjustment leads to a reduction in the expected household income and the income variance reducing the probability to fall below the provincial poverty line from 57% to 33%. However, the reduction in vulnerability depends on the availability of off-farm employment opportunity.

In contrast to the conventional and common static poverty measurement, the concept of vulnerability emphasizes the dynamic problem of poverty which is aggravated by the reciprocal effects of shocks and risks. The overall findings from this study verify the prevalence and severity of poverty and vulnerability among rural households in Thailand as comparable to other emerging market economies. In particular, this research presents a comprehensive analysis of vulnerability to poverty of rural households in Thailand and introduces an alternative methodology for vulnerability assessment. Households in the study area experience most frequently weather-related agricultural shocks as well as health, economic and social shocks. However, they usually need to refer to their own available resources to cope with shocks and the

poor households have limited possibilities to protect themselves against losses from shocks. The application of *ex-ante* measure against weather risks is significantly influenced by the subjective risk perception, which in turn is shaped by the *ex-post* shock experiences. By means of mathematical programming model, it is shown to the contrary of anticipated presumption that a certain typical farm does not profit from the output prices increase in the global and national markets when the input prices simultaneously increase in the larger extent. Lastly, effective social risk management and poverty alleviation scheme needs to recognize different characteristics of households in order to customize different *ex-post* shock-coping actions and *ex-ante* risk mitigation strategies to tackle different types of shocks and risks.

Keywords: shocks, risks, agricultural households, Thailand

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List of abbreviations

ADB	Asian Development Bank
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
BAAC	Bank for Agriculture and Agricultural Cooperatives
CDF	Cumulative Distribution Function
CGE	Computable General Equilibrium
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
ESRI	Enrivonmental Systems Research Institute Inc.
FAO	Food and Agriculture Organization of the United Nations
FGT	Foster-Greer-Thorbecke poverty measures
GAMS	General Algebraic Modeling System
GDP	Gross Domestic Product
GPP	Gross Provincial product
Ha	Hectare
IPCC	Intergovernmental Panel on Climate Change
Kg	Kilogram
Km	Kilometer
Km^2	Square kilometer
MDGs	Millennium Development Goals
MOTAD	Minimization of Total Absolute Deviations
MP	Mathematical Programming
NESDB	National Economic and Social Development Board (Thailand)
NSO	National Statistical Office (Thailand)
OAE	Office of Agricultural Economics (Thailand)
OLS	Ordinary Least Squares
PCI	Per Capita Income
PEM	Partial Equilibrium Models
PL	Poverty Line
PPP	Purchasing Power Parity
TH	Thailand
THB	Thai Baht
UN	United Nations
UNDP	United Nations Development Programme
US$	US Dollar
VN	Vietnam

Chapter 1

Introduction

1.1 Background and rationale of the study

Poverty is a pronounced deprivation of well-being and the inability to acquire the basic necessity for survival with dignity (World Bank 2001). Yet well-being encompasses more than the feeling of hungry, cold and sick, as it compels the spell of ignorance, social exclusion and shame. From Adam Smith's point of view, "[t]he disposition to admire, and almost to worship, the rich and the powerful, and to despise, or, at least, to neglect persons of poor and mean condition, though necessary both to establish and to maintain the distinction of ranks and the order of society, is, at the same time, the great and most universal cause of the corruption of our moral sentiments" (Smith 1759). Poverty exhibits in a variety of dimensions (e.g. consumption, health, education and participation) and has causes in a variety of facets. However, poverty is less a natural fate but more a result of institutional malfunction, as Charles Darwin fervently expressed in his early work, "…[i]f the misery of the poor be caused not by the laws of nature, but by our institutions, great is our sin." (Darwin 1839).

Despite high rates of economic growth in global economies during the last decades, poverty continues to prevail and growing especially in the developing and newly industrialised countries. Based on the World Bank estimates, about 1.4 billion people live below the international poverty line of US$1.25 a day in 2005, equivalent to more than one-fourth of the developing world's population[5]. According to the same source, although poverty incidence gradually declined from 52% of the global population in these countries in 1981 to 25% in 2005, a slower pace in poverty reduction became evident due to a number of recent economic crises which put about 40 million more people in hunger in 2009 and 64 million more people in extreme poverty by the end of 2010. Recognizing the implication of poverty and the lack of success in human development at the global level, Millennium Development Goals (MDGs) were forged by the United Nations together with world leaders in the year 2000 to lay a framework for international cooperation to jointly eradicate poverty in its many dimensions and to ensure fair opportunity to benefit from the global economy[6].

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[5] World Bank Poverty Brief (March 2010) available at http://go.worldbank.org/2UJWJC2XG0, accessed in March 2010.

[6] United Nations Millennium Development Goals, available at http://www.un.org/millenniumgoals, accessed in February 2010.

Poverty measurement is conventionally considered as *ex-post* statistical indicators of well-being usually in terms of income or consumption of individuals or populations. Foster-Greer-Thorbecke (FGT) measure is a widely applied approach to quantify poverty incidence by comparing the well-being of individuals, households or populations with an exogenously defined poverty line (Foster et al. 1984). Based on this approach, a "poor" can be identified if his well-being lies below the respective poverty line while a "non-poor" drifts over and above the line. Although FGT approach may be extended to identify the extent and severity of poverty, the measure has a disadvantage for being static and fails to capture the duration as well as movement in and out of poverty. For a "chronic poor" individual or household that is permanently trapped in poverty, a different poverty reduction strategy is needed as opposed to a "transient poor" individual or household that becomes poor every now and then (Lipton and Ravallion 1995, Duclos et al. 2006, Calvo and Dercon 2007a). Moreover, the nature and cause of poverty should be specified whether it is due to a structural or stochastic element that drives the course of poverty (Carter and Barrett 2006). While a structural poverty is anchored in the insufficient fundamental resource endowment (e.g. asset), stochastic poverty is a result of transitory negative shocks (e.g. a sharp increase in input prices or flooding). Effective poverty alleviation therefore requires that policy should be tailored taking into account the distinct characteristics and conditions of the underlying poverty type. Recognizing the dynamic nature of poverty, vulnerability to poverty is an emerging concept that extends the static character of classical poverty school by incorporating the relevance of risks and shocks as well as persistence and movement of poverty (Ravallion 1988, Calvo and Dercon 2007b). The vulnerability concept offers a forward-looking *ex-ante* perspective on poverty with a focus on the probability that a household would fall below a defined poverty level at a given time in the future (Duclos 2002). In other words, vulnerability concept establishes the relationship between poverty, uncertainty, effects of risk and shocks and the ability to cope with shock *ex-post* as well as *ex-ante* risk mitigation.

On the policy perspective, one of the main targets to tackle poverty is the agricultural sector since the majority of the world's poor earns their living and relies their livelihoods on agriculture in rural area. Especially in developing countries, agriculture has always been the underlying engine of economic growth as a major source of domestic food supply, employment and export earnings (Cervantes-Godoy and Dewbre 2010). However, most agricultural households still belong to the economic and social deprived group compared to the total population. This can be partly attributed to biased economic development policies traditionally pursued in favor of the industrial sector at the expense of the agricultural sector in the 1960s and 1970s (Christiaensen et al. 2010). In this regime, agriculture was viewed as a backward unproductive subsistence sector from which labor and resources should be drawn to foster

development of the dynamic productive industrial sector (Lewis 1954). Agriculture was therefore given merely a supporting role to industrialization strategy. During the course of heavy investment in industrialization and urbanization, agriculture gradually received recognition as an underlying sector critical for faster overall economic growth through substantial multiplier effects although agriculture itself might grow at a slower rate than non-agriculture (Johnston and Mellor 1961, Schultz 1964). Together with the success of green revolution to boost supply of agricultural commodity to satisfy ever-growing demand from expanding population, the image of traditional low-productivity was replaced by a modern fast-growing sector through the adoption of biotechnology (World Bank 2007). Hence, more policy attention and confidence was drawn toward the once-neglected agricultural sector. Nonetheless, the rural farm households hardly received the fruits of development at the lower level of the promising trickle-down effects and the participation of poor farm households in economic growth remains limited.

Apart from institutional barriers, the agricultural sector is subject to inherent susceptibility of natural variability and market volatility. Because agricultural output and income depends on favorable weather, environmental and market conditions, farm households are especially prone to covariate shocks such as flood, drought and price fluctuation more than non-farm households (Dercon 2007). At the same time, farm and non-farm households alike, also face idiosyncratic shocks, e.g. illness or death of a household member. While a significant proportion of farm households struggle to live by each day with less than US$1.25 per person, another proportion of farm households are at risk of falling into poverty if an unexpected negative shock event should occur. The ability of a household to prepare themselves *ex-ante* to reduce the likelihood of experiencing livelihood shocks, for example through income acquisition and stabilization, also reduces the shock damage *ex-post* and the need for coping strategies (Dercon 2002). Furthermore, the ability to cope with shocks may also differ among types of households and their precautionary endowment. In this regard, farm households, especially those who are currently poor or at risk to become poor, may not be well equipped to shield themselves against covariate and idiosyncratic shocks.

In many developing countries, agriculture and farm households receive little attention or failed promises in national development agenda (ADB 2009b). In spite of socio-economic and cultural importance of the sector, farm households have often been neglected and marginalized. As a result, poverty and vulnerability among farm households, regional disparity and overall national underperformance is the inevitable consequence especially when the majority of the population engaged in agricultural sector is concerned (World Bank 2007). This is true even for so-called emerging economies such as Thailand which is an agricultural-based country that enjoys impressive economic growth as one of the fastest and strongest in Southeast Asia but at the same time witnesses the growing regional disparity in income between urban and rural population (NSO 2009, Krongkaew 1985). Thai people have a proud cultural history of being farmers who serve as the backbone for the country and Thailand remains the world's number one exporter of rice in both volume and value until present[7]. Based on the World Bank estimates[8], agriculture is the major source of employment for 42% of total workforce compared to 21% in industry and 37% in service sector in 2007. However, agriculture contributes only about 11% to GDP with 1% annual growth lacking behind roughly 45% GDP share and 6% annual growth from the industry sector and around 45% GDP share and 5% annual growth from the service sector. In 2004, among 64 million residents, 2% are living in extreme poverty below US$1.25 per person per day and 12% are struggling in poverty to live by below US$2 per person per day. At the same time, when measuring in national poverty line of US$2.80 per person per day, the poverty headcount ratio amounts to 8.5% with a substantial depth of poverty measured by the poverty gap ratio of 1.45 in 2007[9]. A considerable income inequality is evident with a Gini ratio of 42 and the highest 20% of the population receive 49% of total income share while 6% is distributed to the lowest 20%.

The majority of the poor are farm households in rural areas especially in the Northeastern region where agriculture represents the largest economic and employment sector (NSO 2009, Fukui 1993). Locating on the dry Khorat Plateau with less fertile soil and a long dry season, the area is not ideal for agriculture except for rice cultivation which requires flooded paddy fields (Crews-Meyer 2004). As a consequence of climate change and environmental degradation, the region is subject to substantial weather risks although the risk of extreme weather event such as Tsunami is lower than in the Southern counterpart (Yusuf and Francisco 2009). Nonetheless, farmers annually experience a long period of dryness before the monsoon season brings heavy flooding which is often followed again by sudden drought (Rigg 1991, 1995). On the economic side, traces of the 1997 Asian Economic Crisis still remain and they are accentuated by the recent global financial and food price crises. During the Asian Economic Crisis, the agricultural

7 FAOSTAT, available at http://faostat.fao.org, accessed in January 2011.
8 World Bank, *Thailand Data Profile*, available at http://www.worldbank.or.th, accessed in January 2011.
9 NESDB.

sector served as a buffer to absorb migrant members who were forced to move back from the industrial and the service sectors to their rural origin (ADB 2009b, Subhadhira et al. 2004, Bresciani et al. 2002, Siamwalla 1999). The recent global financial and food price crises put the farm households in a situation where credit shortage, high loan default rate and price fluctuation was unanticipated (Llanto and Badiola 2009). The food price crisis, in particular, offered an opportunity for producers of cash crops but the accompanying historical hike in prices of major input such as fuel and fertilizer partially cancelled out the positive prospect (Isvilanonda and Bunyasiri 2009). Over the last few years, a number of violent political unrests and demonstrations have not been favorable for a robust development and added burden to the negative risks that farm households in Thailand must bear[10].

Considering the preceding background information, it is essential from a socio-economic development point of view to extend the research effort to better understand the nature and causes of poverty and vulnerability in rural farm households. Extensive and comprehensive analysis of the nature, effects and responses of shocks and risks will provide useful insight for development policy to critically and effectively alleviate poverty among the majority of the poor. For this purpose, a group of universities and research institutions in Germany, Thailand and Vietnam collaborated in a research unit funded by the German Research Foundation (DFG) on the research project "Impact of Shocks on the Vulnerability to Poverty: Consequences for Development of Emerging Southeast Asian Economies" (DFGFOR756[11]). In particular, the research study presented in this thesis was conducted under the collaboration and support of the DFGFOR756 research unit.

[10] Immigration and Refugee Board of Canada, *Thailand: Overview of the political situation (2006-2008)*, January 2009, available at http://www.unhcr.org/refworld/docid/49913b5e42.html, accessed in February 2011.

[11] DFGFOR756 is a Deutsche Forschungsgemeinschaft (DFG)-financed 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 or http://www.dfg.de

1.2 Research objectives

The overall aim of this research study is to analyze the phenomena of poverty and vulnerability among small-scale agricultural-dependent households living in rural areas in Northeast Thailand by assessing the characteristics and effects of common shocks and risks faced by rural farm households including respective *ex-post* shock coping and *ex-ante* risk mitigation strategies. This aim can be achieved by focusing on three specific research objectives addressed below.

(I) The first specific research objective of this thesis is to identify and classify types and effects of shocks and to analyze *ex-post* coping behavior of the households in three provinces in Northeast Thailand: Buriram, Ubon Ratchathani and Nakhon Phanom.

The rationale for the first specific objective is to better understand the situation in which rural households reside and operate. In general, rural households are usually subject to negative shocks which have a direct implication on household's well-being through loss of income, asset or resources. Hence it is important to first assess the types and severity of shocks relevant for rural households. Furthermore, it is also important to understand how rural households cope with shocks and whether different shocks call for a different pattern of coping behavior since the choice of coping actions indirectly influences household's situation in the future periods. In particular, determinants of a household's decision to undertake coping actions and the choice of a specific coping activity will be identified in order to provide more effective social risk management strategies.

(II) The second specific objective of this thesis is to assess the relationship between weather-related shock experience and subjective perception of future weather risks as well as its influence on the application of *ex-ante* risk mitigation strategies of rural households in the three provinces in Northeast Thailand. Results of the analysis are compared to those derived from a corresponding analysis of data from three provinces in Vietnam[12].

The second specific objective extends the implication of shock experiences in the past to future timeframe perspectives. Contrary to *ex-post* coping actions reactive to shocks, *ex-ante* risk mitigation strategies are shaped by a subjective perception of risk which in turn is influenced by previous shock experiences. Taking into account the dependency of agriculture on weather conditions, this objective offers a unique analysis to explore the linkage between subjective weather risk perception and the decision to apply specific *ex-ante* risk mitigation actions.

[12] See Völker (2010).

(III) The third specific objective of this thesis is to assess the impact of the global food and input price shocks in 2008 on vulnerability to poverty of rural farm households in Northeast Thailand. For this purpose, a new approach to evaluate vulnerability has been developed by means of mathematical programming. The model set up comprehensively mirrors the economic situation of a typical household in Ubon Ratchathani province. It is used not only to demonstrate the adjustment behavior to the price shocks observed, but at the same time to account for weather risks in order to generate information on the effects of risk on the household's adjustment decisions and the resulting level of vulnerability.

In addition to common types of shocks such as flooding, drought or illness of household members which are regularly anticipated although unpredictable, economic shocks on the market side represent another significant type of unexpected events which impose further constraint on a household's production and consumption portfolio. The recent historical hike in global food prices along with a drastic increase in fuel and fertilizer prices are particularly relevant for farm households. For this objective, the new approach based on mathematical programming model is set up to capture the complexity of farm households' decision-making behavior. This approach has advantages over conventional regression-based vulnerability measurement especially when time series data for the purpose of behavioral response is scarce. With the alternative approach, the analysis is based on farm household modeling allowing for interdependency of various farm production factors and non-farm income-generating components as well as incorporating weather-related shocks as endogenous elements in the optimization of whole-farm objective subject to a set of resource constraints.

1.3 Conceptual framework

The analytical framework for the thesis is a household approach in the context of vulnerability to poverty concept. In general, vulnerability "measures the resilience against a shock – the likelihood that a shock will result in a decline in well-being" (World Bank 2001). The concept of vulnerability recognizes the dynamics of poverty and takes into account that the impacts of unexpected negative events (i.e. shocks) lead to fluctuation of households' welfare over time. This notion of uncertainty entails a differentiation between the expected well-being of a household, which is largely contingent upon the household's endowment of assets, and its realized well-being, which can be affected by (negative or positive) stochastic events (Morduch 1994, 1995). The general objective of vulnerability analysis is the *ex-ante* measurement of a household's probability to be below a certain welfare threshold in the future (Hoddinott and Quisumbing 2003).

The growing literature has produced a vast of approaches aiming to identify and quantify vulnerability level. At present, although there is no official consent definition or measurement of vulnerability, four popular concepts of vulnerability can be distinguished: (*i) Vulnerability as uninsured exposure to risks* is an *ex-post* assessment of the extent to which a negative shock leads to a welfare loss defined as a change in consumption between before and after shock periods (e.g. Jalan and Ravallion 1999, Dercon and Khrishnan 2000, Elbers and Gunning 2003, 2006, Morduch 2005); *(ii) Vulnerability as expected poverty* extends the static Foster-Greer-Thorbecke (FGT) poverty measures to make estimation on the probability that a household will fall below a predefined poverty line in some future period (e.g. Pritchett et al. 2000, Christiaensen and Subbarao 2001, Chaudhuri et al. 2002, Chaudhuri 2003) and clearly distinguishes between transient and chronic poverty (see Figure 1.1); *(iii) Vulnerability as low level of expected utility* defines vulnerability as the difference between the utility derived from some level of certainty-equivalent consumption below which the household is considered as vulnerable, and the expected utility of that consumption (e.g. Ligon and Schechter 2003, Günther and Maier 2008); and *(iv) Vulnerability as expected deprivation* which measures individual vulnerability accounting for the probabilities of negative future events and their severity (Calvo and Dercon 2005). In this study, the notion of *vulnerability as expected poverty* is applied as a basis for subsequent analyses throughout the thesis.

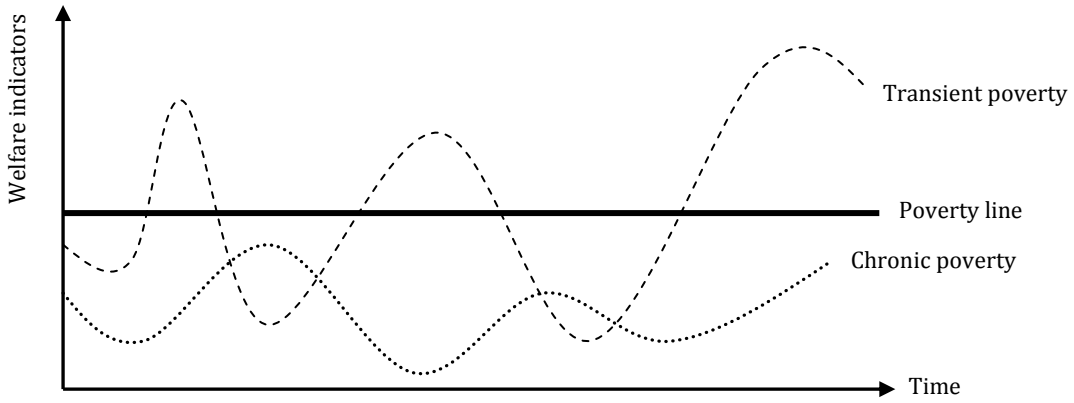

Figure 1.1: Dynamic poverty concept applied in vulnerability as expected poverty concept
Source: Own illustration.

An analysis of the impact of external shocks on vulnerability of poverty requires a framework that incorporates details on how rural farm households take on production and consumption by utilizing their resources and allocating them to different income-generating activities in a given situational setting. The household approach assesses household's well-being by use of different welfare indicators such as income or consumption and to yield a comprehensive analysis of different activities and their interrelations (Norman et al. 1995). Hence the household approach is an appropriate tool for evaluating the impact of shocks and risks on poverty and vulnerability (World Bank 2003b). Figure 1.2 illustrates a simple rural farm household system within the context of vulnerability to poverty. First, a typical rural farm household is assumed to have three fundamental production factors, which consist of labor, capital, and natural resources. In addition, market participation or market access is generally a pre-condition for production to acquire inputs and to distribute outputs. Second, the household makes a decision how to allocate his resources to different income-generating activities. On the one hand, a household may engage in farm activities such as cropping and livestock. On the other hand, the household may as well occupy his resources in off-farm and non-farm enterprises. Third, farm households generally take on a dual role of agricultural producer for market supply as well as consumer of self-produced agricultural output for subsistence consumption. Hence, the farm household is subject to an additional aspect of decision-making between the amount to produce and the amount to consume. Fourth, the household may undergo an episode of shock incidences of covariate or idiosyncratic nature which prompt for *ex-post* coping action. Based on accumulated experiences with shocks and the effectiveness of *ex-post* coping activities, household subjectively estimate the likelihood of future endogenous and exogenous risks[13] and decide upon *ex-ante* mitigation strategies. Once again the effectiveness of *ex-ante* risk management can influence the likelihood of shock occurrence and severity which triggers another round of *ex-post* coping

[13] Endogenous risks refer to risks that originated from within the system. In contrast, exogenous risks emerge from outside the system.

behavior. As a result of the full multi-layered decision-making process for all activity elements, household's well-being can be assessed by some indicators such as income or consumption. In a given period, a dynamic poverty can be observed as household's income and consumption that may lie above the predefined poverty line at a certain point in time but fall into poverty at another point.

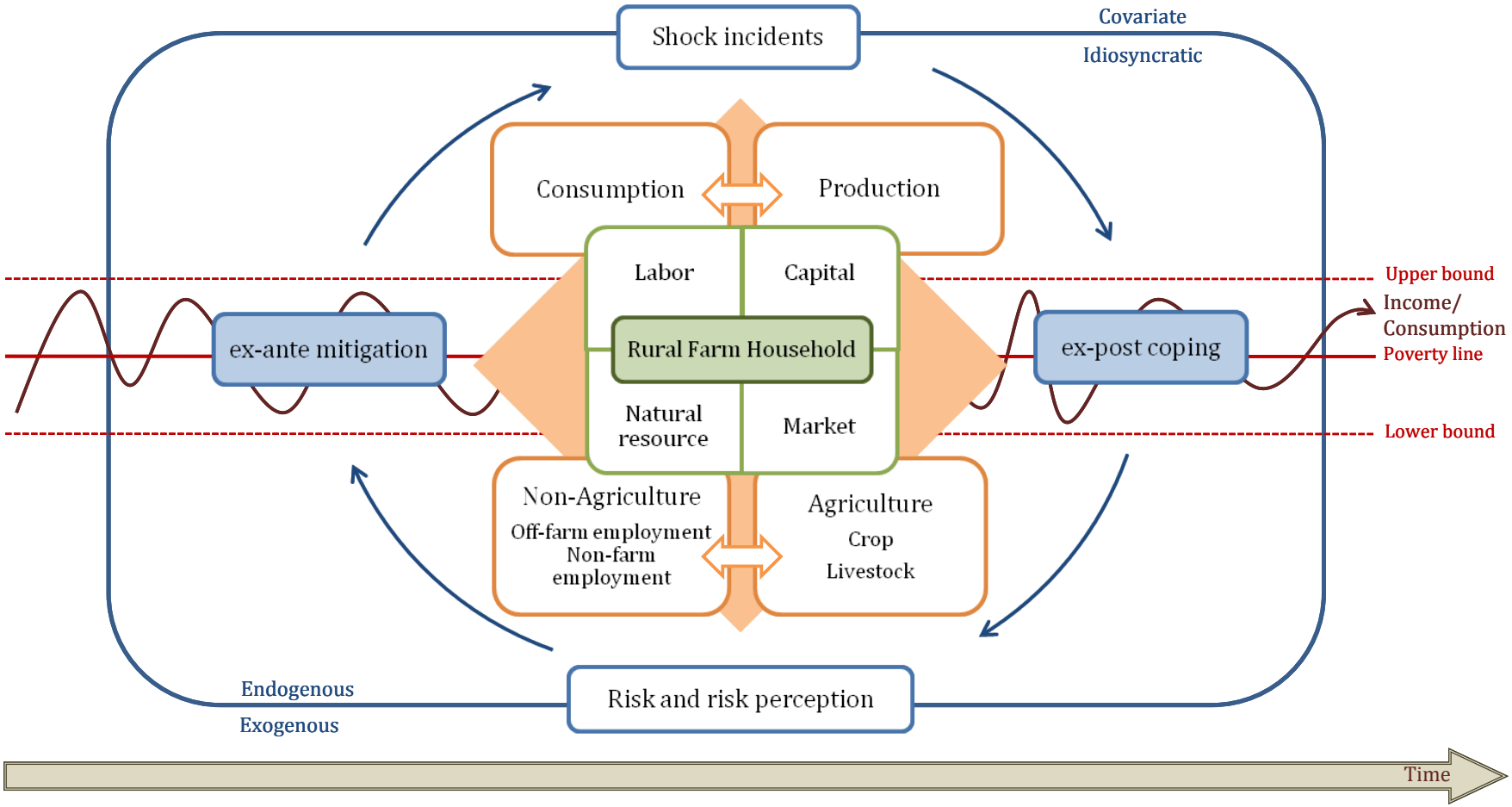

Figure 1.2: Conceptual framework of rural farm household system within the vulnerability as expected poverty concept

Source: Own illustration.

1.4 Organization of the thesis

This thesis is organized as follows:

Following these introductory remarks (chapter 1), chapter 2 gives an overview of the study area and describes the methodology of data collection applied to generate the household datasets used in this study. In particular, it introduces the three provinces covered in this study and explains the general research design, including the sampling procedure and household selection, the survey instrument and implementation. More importantly, preliminary descriptive statistics of the sampled households are presented. The chapter provides the foundation for the empirical applications in the subsequent chapters 3 to 5.

Chapter 3 elaborates the "*ex-post* shock" aspect of vulnerability through identification and classification of common shocks and their effects on income and assets of rural Northeastern Thai households in Buriram, Ubon Ratchathani and Nakhon Phanom provinces. After the typical shock situations are described, associated *ex-post* coping activities are presented. In particular, households' behavior regarding decisions on coping action and the choice of coping measures are assessed by the application of univariate- and multivariate probit regressions. Results are generated from a comparative static analysis of the two-period panel data sets. This is the first step to obtain a broader picture of shock situations and coping behavior.

In chapter 4, the *"ex-ante* risk" aspect is explored by establishing the causal relationship between weather-related shock experiences, subjective risk perception and the decision to undertake *ex-ante* mitigation strategies of vulnerable rural households. Corresponding to the three-step decision-making procedures of *ex-ante* risk mitigation application, three regression models are applied for all three provinces in Northeast Thailand and the results are compared with the surveyed households in Vietnam. In the first step, household's subjective weather risk perception is explained by controlling for the short-term effect of weather-related shocks on household's risk expectations as well as for poverty status and other socio-demographic factors that influence risk perception. The second step is to assess the influence of subjective weather risk perception and poverty status, among other determinants, on adoption and non-adoption of *ex-ante* risk mitigation actions by applying a standard univariate probit regression model. In the third step, the likelihood of household's decision to choose specific *ex-ante* risk management strategies with regards to their subjective weather risk perception and poverty status as well as other determinants is established by estimating bivariate- and multivariate probit regression models. Results provide a comprehensive starting point for *ex-ante* weather risk mitigation analysis focusing on vulnerable rural households based on the implication of weather risk perception.

Chapter 5 analyzes the impact of recent global food and input price crisis on the adjustment of rural farm households' activity portfolio and the resulting consequence on their vulnerability to poverty situation. To pursue this objective, a new approach based on mathematical programming model of typical farm households is developed and applied to advance the methodology of vulnerability to poverty analysis. In order to set up a comprehensive behavioral model in this framework, detailed information has been collected from a purposively selected sub-sample of 64 households to represent 8 different groups of typical farm households in Ubon Ratchathani province. The analysis draws on 8 households corresponding to one specific group of typical households that is currently poor and vulnerable relying on agriculture as major source of income and implements dual cropping-livestock production system. Under different price scenarios, income-generating activities in the typical farm household model are optimized to maximize household income under current production technology, resource constraints and endogenous risks. The resulting household income from the adjustment is then used to assess the food and input crisis impact on vulnerability to poverty.

Finally, chapter 6 provides a synthesis of this thesis, summarizing the results, drawing conclusions and giving recommendations for policy makers as well as future research.

Chapter 2

Data collection and general descriptive results

2.1 Introduction

This chapter describes the data collection methodology, which was applied to obtain comprehensive household data used in this study, and presents general descriptive results of the collected data to characterize the household situations in the study area as well as to establish an underlying database for the research objectives as indicated in chapter 1. First, the study sites of three provinces in Northeast Thailand are introduced. Thereafter, the overall sampling design as well as survey instrument and data collection procedure is explained in details. The last section of the chapter presents and summarizes descriptive characteristics of the sample households.

2.2 Study area

This study was conducted within the research project on "Impact of Shocks on the Vulnerability to Poverty: Consequences for Development of Emerging Southeast Asian Economies" (DFGFOR756) covering six provinces in Thailand and Vietnam. For Thailand, the study area includes Ubon Ratchathani, Buriram and Nakhon Phanom provinces located in Northeast Thailand along the border to neighboring Laos and Cambodia (see Figure 2.1). According to available statistics (e.g. NSO, NESDB, OAE), this region fulfills the major criteria emphasizing the prevailing poverty incidence and significant dependency on agriculture of rural poor households as a major economic activity under risky environment. Allowing for a certain degree of variation in agro-ecological conditions, the three peripheral provinces were purposively selected to target rural households who are either poor or at risk of falling into poverty (Hardeweg et al. 2007).

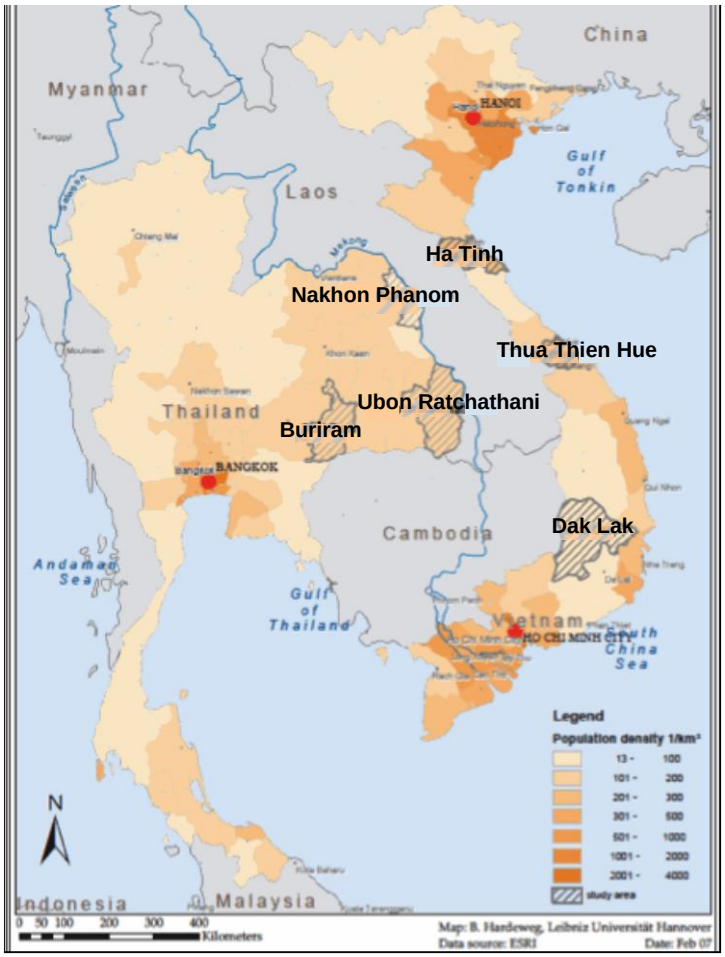

Figure 2.1: Map of South-East Asia showing the study areas of the DFGFOR756 research unit

Source: ESRI, adapted by Hardeweg, Leibniz University Hannover.

The largest and comparatively most advanced developed province among the three, Ubon Ratchathani, is Thailand's easternmost province. It lies about 629 km away from the capital city Bangkok and it is the only province which borders both neighboring countries: Laos to the East and Cambodia to the South. With the total area of 16,112 km^2 it is the 5th largest province in the country with the inhabitant size of 1,774,808 in 2005 (4th national rank, 2.7% of total population). Geographically, the province is located on Korat Basin and Mun River banks with a hilly terrain. The plateau has a downward slope toward the East in the direction of Khong River which borders Laos and Thailand. There are 7 main rivers which flow throughout various districts and 2 hydroelectric dams located in the Sirindhorn district. The province is blessed with abundant forest in the South, the North and the Southeastern districts. On average, the province receives high rainfall which periodically causes depression storm and flooding during the rainy season. By contrast, the rainfall is usually insufficient during summer months and makes it difficult for agricultural activity. The majority of Ubon Ratchatani belongs to Thai ethnicity but a significant influence of Laos is prevalent in the local language and culture.

The second province, Buriram, is located to the West of Ubon Ratchathani, at the southern end of the Korat Plateau bordering Cambodia to the South. It has an area of about 10,322 km^2 (national rank 17th) and inhabitants of about 1,524,261 in 2005 (national rank 6th, 2.3% of total population). The province is dominated by high plateau with a mountainous area in the South, ripply plain in the Central and flat plain in the North on the Mun River bank, as a result of ancient volcanic activities. Buriram also shares a portion of Tung Kula Rong Hai which is one of the most important jasmine rice production areas in Thailand. Officially, Thai is widely spoken while 27.6% of the population speaks Northern Khmer dialect in daily life.

To the North of Ubon Ratchathani, Nakhon Phanom is located at the valley of the river Mekong bordering Laos to the East. The landscape is mostly plain with somewhat upland character and forest covered plains in the northern part. Two main rivers Mekong and Songkram run in the northern part while there is only one notable river in the flat south. With an area of about 5,512 km^2 (national rank 39th) and inhabitants of about 691,160 in 2005 (national rank 36th, 1.05% of total population), it is the smallest province among the three. A significant portion of the population belongs to Phu Thai ethnic group with its own dialect.

The three study provinces share a number of similar socio-economic conditions (see Table 2.1). Apart from manufacturing and trade, agriculture remains one of the three most important economic sectors with a significant share of Gross Provincial Product (GPP) ranging from 15.7% in Ubon Ratchathani to 23.4% in Buriram and 27.2% in Nakhon Phanom. On average, more than 40% of total land area is utilized for agriculture with the largest proportion allocated to rice and other field crop cultivation. With an average household size of 4 persons, the majority of the households engaged in agricultural activity holds an average farm size of about 3 ha. Household monthly income is highest in Ubon Ratchathani (PPP$ 700) and roughly equal in Buriram and Nakhon Phanom (almost PPP$ 600). However, poverty is prevalent as almost 14% of the total population in Ubon Ratchathani is currently living below the provincial poverty line and the poverty incidence is even more severe in Nakhon Phanom (17.87%) and Buriram (23.84%).

Table 2.1: Socio-economic information of the study area

	Unit	**Buriram**	**Ubon Ratchathani**	**Nakhon Phanom**
Population[1) a)]	*persons*	1.524.261	1.774.808	691.160
Population density[1) a)]	*persons/km2*	147	110	125
Gross provincial product (GPP)[2) c)]	*million PPP$*	2972	3952	107
GPP per capita[2) c)]	*PPP$*	1832	2151	1722
Agriculture	*% of GPP*	23,4	15,7	27,2
Manufacturing	*% of GPP*	12,2	12,1	2,9
Trade	*% of GPP*	22,6	26,3	19,4
Area [3) b)]	*ha*	1.032.188	1.574.484	551.267
Forest land [3) b)]	*ha*	95.180	271.160	132.180
Agricultural land [3) b)]	*ha*	629.368	761.547	237.103
Rice	*ha*	501.815	549.297	172.770
Field crop	*ha*	69.196	46.012	4.686
Permanent crop	*ha*	32.847	43.354	23.117
Vegetable and flower	*ha*	1.876	3.449	2.536
Pasture	*ha*	2.616	6.637	2.084
No. of farm households [3) b)]	*farms*	172.119	216.781	97.607
Farm size per farm household [3) b)]	*ha*	3,7	3,5	2,4
Income per household [1) c)]	*PPP$*	564,4	700,4	577,8
Poverty line[2) c)]	*PPP$/capita*	77,2314	75,66	77,697
Poverty incidence[2) c)]	*%*	23,84	13,69	17,87

Note: [a)] 2005; [b)] 2006; [c)] 2007
Source: [1)] NSO); [2)] NESDB); [3)] OAE

2.3 Sampling design and data collection

To prepare accommodating framework for vulnerability to poverty analysis in this study, a comprehensive database containing extensive household information is essential. In particular, the scope of data requirement contains two major components. First, general household demographic and socio-economic information, especially past shock experiences, *ex-post* coping actions, future risk perception and *ex-ante* mitigation strategies, is needed to capture household-specific characteristics attributable to vulnerability to poverty situation. Second, in-depth information regarding agricultural aspect including production portfolio, farm practice, household resources and constraints are necessary to construct relevant and realistic foundation of rural farm households' decision-making behavior. In addition, the database should capture information from habitual annual cycles emphasizing the main agricultural production practices as well as from different points in time to articulate the dynamics of vulnerability to poverty.

With respect to the two data components, two complementary data sources are combined to generate a complete dataset for this study. The general data is extracted from two-period base panel surveys while the in-depth agricultural data components are collected from additional two-period panel in-depth surveys, as explained in the following.

2.3.1 Base panel survey [14]

The sampling design of base panel survey aims to obtain a representative sample of the target population of rural and peri-urban households who are currently poor or at risk of falling into poverty in the study area. To achieve an optimal degree of sample representativeness while compromising with the available survey budget, a 3-stage cluster sampling technique was employed. As a result, a total of some 2,200 households in each country were initially interviewed in 2007 and followed-up in the base panel survey in 2008 in six selected provinces in Thailand and Vietnam (see Figure 2.1). Together with a village survey, which was conducted in 2007 among the heads of all surveyed household villages, the base panel survey generates a unique and comprehensive database.

The study presented here focuses on the three provinces in Northeast Thailand: Ubon Ratchathani, Buriram and Nakhon Phanom where data of some 2,200 households were captured and followed-up in the same panel survey. With three provinces representing target population, the multi-stage sampling procedure takes into account the geographic dispersion of sample villages and logistic feasibility. Based on available secondary household data provided by the Department of Community Development (Ministry of the Interior) as well as the village-level database (NRC2D), sufficient homogeneity in population density and agro-ecological conditions could be assumed and hence a simple self-weighting sample was feasible.

In stage one, provinces were treated as constituted strata with approximately proportional allocation of primary sampling units, i.e. sub-districts (Tambon). Note that the district level (Amphoe) was omitted since it is an essentially administrative unit with no anticipated impact on vulnerability to poverty. In order to ensure proportional coverage of peri-urban (higher population density) and rural (lower population density) areas, systematic random sampling with implicit stratification based on a list ordered by population density was applied. As a result, 494 sub-districts were selected based on probability proportional to population size. In stage two, two villages from each sampled sub-district were selected based on simple random sampling with the probability proportional to size from each of the sampled sub-districts. In stage three, due to organizational reasons, the final cluster size of 10 households per village was systematically selected from the household database (BMN) with implicit stratification by household size with equal probability of selection. Furthermore, 40% replacement rate, i.e. 4 additional sampled households per village, was added to anticipate possible ineligibility of households. Table 2.2 gives overview of basic data for target population and household sample for three provinces.

[14] The description of sampling and household selection for the base panel survey is based on Hardeweg et al. 2007.

Table 2.2: Basic data for target population and household sample

	Rural population	No. of households	Share of provincial strata	No. of sub-districts	Sample size (households) 1st wave	Sample size (households) 2nd wave[a]	Probability of selection for a household
Buriram	956,497	228,823	37.60%	184	820	799	0.36%
Ubon Ratchathani	1,142,219	271,213	44.60%	215	980	950	0.36%
Nakhon Phanom	444,562	108,662	17.90%	95	400	387	0.37%
Total/Average	2,543,278	608,698	100.00%	494	2,200	2,136	0.36%

Note: [a] The reduction in sample size is due to sample attrition between the two survey periods.
Source: Hardeweg et al. (2007)

Regarding the survey instrument, data in the base panel surveys was collected from household and accompanying village head interview using questionnaires. Different areas of economic departments including agricultural economics, economics of poverty dynamics, financial institutions and economic geography worked jointly to develop the base survey questionnaires[15] with the aim to capture various components of vulnerability to poverty. In the household questionnaire, data on the following aspects were collected:

(i) Household composition and household dynamics: socio-demographic information on each member's social, occupational, educational, and health status as well as temporary and permanent in- and outmigration and remittances.

(ii) Experiences with shock incidences during the past: monetary losses, subjective severity estimation, *ex-post* coping actions, coverage and duration of shock; and risk perception of threatening events in the future: subjective frequency and severity estimation of risk events as well as *ex-ante* mitigation added in the second wave.

(iii) Agricultural activity: land endowment, cropping and livestock production as well as fishing, hunting, collecting and logging.

(iv) Off-farm and non-farm employment: type, location, duration, earnings, costs and revenues.

(v) Financial situation: borrowing and lending, savings, public transfers and insurances.

(vi) Household expenditures: food and non-food, transportation and communication, education, health and social expenditures.

(vii) Household wealth: number and value of assets and housing conditions.

[15] See http://www.vulnerability-asia.uni-hannover.de for the full version of questionnaires for the household and village-head surveys.

To capture the seasonality of the cropping cycle of major agricultural activities and to take into account cultural practices of the locals, both base panel surveys were conducted in April immediately after Thai traditional New Year festival (see Table 2.3). The collected data is a combination of retrospective information based on respondents' memory recall of facts in the past and subjective estimation of the future. The reference period for both surveys is 12 months backwards from April in the current survey year to May in the previous year, i.e. May 2006 – April 2007 for the first wave and May 2007– April 2008 for the second wave. For some sections, e.g. shock experience, household dynamics, and risk perception, different reference periods were applied. While an extended recall period of past 5 years (January 2002- April 2007) was applied to shock experiences and household dynamics in the first survey, the general reference period (May 2007–April 2008) was applied for shock experiences in the second survey. In both survey years, the risk perception section requests the respondents to estimate the likelihood of occurrence of risk events for the next 5 years.

Table 2.3: Illustration of farming calendar and survey periods

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rice calendar					Preparation		Farming				Harvest	
Cassava calendar	Harvest				Preparation		Farming					
2007				base 1[a, c]								
2008				base 2[b]	in-depth 1							
2009	in-depth 2											

[a] Reference period: May 2006 - April 2007 with some sections referring to the last 5 years.
[b] Reference period: May 2007 - April 2008
[c] Village survey was conducted.
Source: Own illustration.

In addition to panel household interview, a one-time village survey was conducted with the respective village head in the first survey year. With a separate village head questionnaire, the village survey aims to collect information concerning the infrastructure and institutions of each surveyed village such as geographical position, size of the village, access to infrastructure, major economic activities, source of employment and natural resource availability.

The base panel survey in both waves was carried out by collaboration among partners in the DFGFOR756 research unit project. Three survey teams were assigned to each province with each team consisting of 8 student enumerators from Kasetsart University (official national collaborator) and 4 local staff enumerators. The teams were supervised by provincial survey leaders who are PhD students affiliated with the German institutions involved in the project, including the author. Before the survey began, the enumerators were trained with the project background, the questionnaires, interview techniques and interview exercises with test households. One month prior to the survey, courtesy letters were sent to the provincial mayors

and the village heads informing about the research activity in the selected villages. The corresponding coordinator in each province arranged the appointment approximately 2 weeks beforehand and the exact date and time was confirmed at least 1 day before the field trip schedule.

The first wave of base survey started on 19th – 20th April 2007 and the second wave survey followed-up on 18th –19th April 2008. Both waves were completed after approximately 6 weeks. During the first wave, an approximately 20-minutes village head interviews were additionally conducted by the provincial survey leaders prior to the household survey of the villagers. In most cases of the household survey, the interview took place at the household's residence. Average interview duration was between 1 hour and 1 hour 40 minutes as the information size and complexity vary among the households across the sample. Upon completion of the interview, a small gift was given to the household and the village head as a token of appreciation for their time and information. The process of data controlling including necessary follow-up interview, data editing and data entry was carried out directly during the survey and the data was regularly exported to the central data management unit at the Institute of Development and Agricultural Economics, Gottfried Wilhelm Leibniz University of Hannover.

2.3.2 In-depth panel survey

In addition to the data collected from base panel survey which cover the broad view of household characteristics in the three provinces, supplementary in-depth panel survey was implemented to generate detailed information that mirror rural farm households' behavior regarding production, consumption and decision-making. The in-depth survey focuses on extensive information that describes the technical production processes and consumption characteristics as well as specific constraints typical for the research area. This additional information assist the analysis based on "typical farm" approach which aims to illustrate the agricultural production systems and the decision making behavior of rural "benchmark" farm households (see chapter 5). In this context conceptualized by the Agribenchmark project[16], a typical farm is farm households being indicative for a substantial share of the farm household population with typical production and consumption characteristics for the conditions of the rural households in a defined region. To overcome data scarcity, lack of representativeness of data, and large data collection costs confronted by conventional individual and average farm data requirements, typical farm approach allows reasonable analysis provided by a small sample

[16] Agribenchmark project is a part of the German Federal Agriculture Research Center (FAL) and the German Society of Agriculture (DLG).

size[17]. Hence, a reduced survey size in a concentrated geographical area is sufficient and ensures the heterogeneity of socio-economic and natural frame conditions to a manageable level.

For the purpose of this study, a "typical farm household" should be characterized by primary engagement in agricultural production, being vulnerable to poverty and having experienced shocks in the recent past. Preliminary results from the first wave of the base panel survey in 2007 show that Ubon Ratchathani has a major share of the population made up of farm households who are often poor or vulnerable to poverty as well as frequently affected by weather-related shocks especially flooding and drought. Therefore Ubon Ratchathani province was purposively chosen to be an extensive research area for this study by eliciting in-depth data collection from a smaller sub-sample of typical rural farm households in the province. Based on the data provided by the first wave base panel survey, a sub-sample of 64 households from the original 970 sample size was drawn and an additional in-depth panel data collection activity was carried out in 7 districts in Ubon Ratchathani province (Figure 2.2).

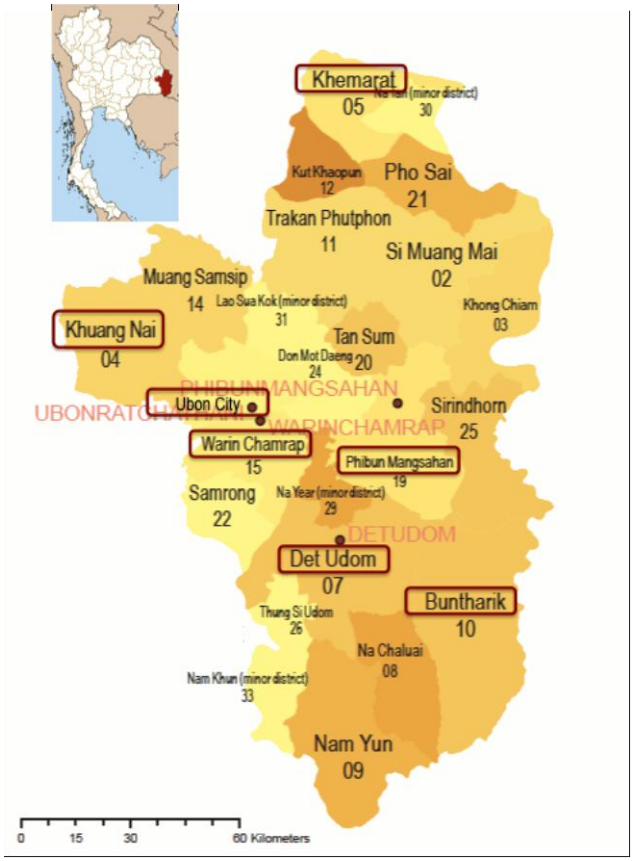

Figure 2.2: Map of Ubon Ratchathani province indicating selected districts for the in-depth survey

Note: The numbers denote district administrative unit and have no other direct interpretation.
Source: Adapted from Hardeweg et al. (2007) and Tourism Authority of Thailand

[17] http://www.agribenchmark.org/methods_typical_farms.98.html, accessed in March 2011.

Whereas the base survey applied the 3-stage stratified cluster sampling approach, the in-depth survey applied a semi-purposive selection based on ad-hoc filtering criteria followed by random sampling of households within the sites. The selection of typical farms among the rural agricultural households surveyed follows a pragmatic filter and identification approach as depicted in Figure 2.3 (Tongruksawattana et al. 2008). First, the complete sample size of 980 households from the base survey in 2007 undergoes several ad-hoc filter criteria which ensured the common characteristics concerning agricultural and vulnerability to poverty aspects including experiences with shocks. Second, the selected households are regrouped according to their common characteristics to allow the identification of 8 principle groups of typical farms as explained in the following.

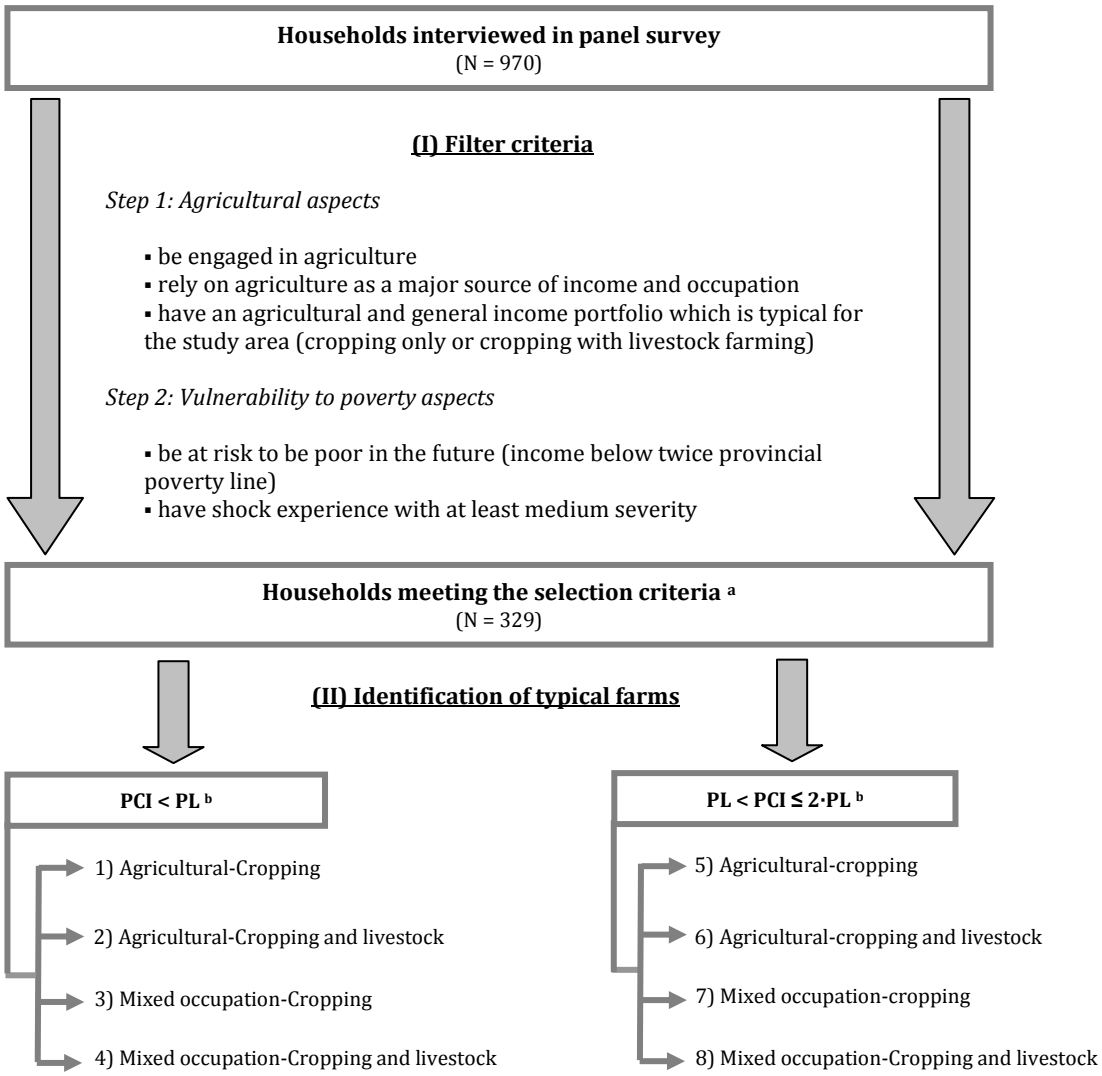

Figure 2.3: Typical farm household selection procedure

Note: [a] To accommodate organizational constraints, 64 households were randomly selected corresponding to 8 groups of typical farm. [b] PCI = per capita income. PL = poverty line.
Source: Based on Tongruksawattana et al. (2008)

(1) Filter criteria

To identify typical farms, several ad-hoc filter criteria had been applied following a two-step procedure to ensure the agricultural and vulnerability to poverty aspects of the households.

On the agricultural aspect (step 1), the first filter criterion (F1-1) strictly requires household's engagement in agriculture to exclude non-agricultural households and absolute dependency on off-farm agricultural employment and remittances. The next filter criteria (F1-2) requires households to have a significant share of their total household income and occupation from agriculture. In this respect, an auxiliary variable of occupation is used such that at least 25% of household members must report agriculture as primary or secondary occupation. Since very few households completely engage in agriculture and rely totally on agricultural income in Thailand, the threshold anticipates widespread (seasonal) off-farm and non-farm self-employment. Therefore, "agriculture" means very high share of agricultural income to allow for some "non-agricultural" income. The last filter criteria (F1-3) requires households to have an agricultural and general income portfolio being typical for the study area. In particular, this filter selects farm households that engage in cropping only or cropping together with livestock farming. Households that exclusively concentrate on livestock production without cropping activity were removed because such households are very few.

On the second aspect vulnerability to poverty aspect (step 2), the first filter criterion (F2-1) draws an income ceiling of twice the provincial poverty line of THB 1,215 (approximately PPP$ 72.90) per capita per month to include not only households who are already poor but also households at risk of falling below the poverty line. No income floor is set as households with extremely low income may have recently experienced a major shock event that pushed households below the poverty line. Lastly, the next filter criterion (F2-2) selects households who reported having experienced at least one shock during the past five years with at least medium or high subjective severity. Shocks with low severity are generally assumed to have negligible effects on household's well-being and therefore less likely to encourage specific coping action. As a result, 641 households were filtered out during the procedure and 329 households remained suitable to deliver information on typical farms.

(2) Identification of typical farms

To derive indicative typical farms households, 329 remaining households from the previous filter procedure are regrouped according to three dimensions: 1) per capita income per month; 2) occupation of household members; and 3) agricultural production system. Each of these dimensions can be further classified into two levels as following.

(i) For the first dimension of income, households are divided by the provincial poverty line: ***a) below*** and ***b) equal to and above***. Hence, the first group represents the depth of current poverty and the second group signifies vulnerability to poverty, i.e. a considerable chance to fall below the poverty line when taking future uninsured risks into account.

(ii) The second dimension of occupation is applied to indicate the level of agricultural intensity and share of agricultural income of the households. Due to the fact that (seasonal) off-farm and/or non-farm self-employment is very common among rural households in Thailand, agricultural households can therefore be categorized as being ***a) mainly agricultural*** if at least 60% of household members engage in own agriculture, or as having ***b) mixed occupation*** for the contrary.

(iii) Regarding the last dimension, production system is an indicator for agricultural specialization. In Thailand, most agricultural households operate in either ***a) cropping*** with small degree of subsistence livestock farming; or ***b) mixed cropping-livestock farming*** for commercial purpose.

Assigning the remaining 329 households to the three dimensions reveals an almost even distribution in all levels. Exactly half of the households earn less than the provincial poverty line and the other half earns twice the amount at most. 60% of the households engage mainly in agriculture while another 40% also work off-farm and non-farm self-employed. Furthermore, almost half of the households concentrate on cropping and the rest operate a mixed system of cropping and livestock farming. Based on the two-levels of all three identification dimensions, 8 typical household groups can be defined for which 8 different models could be developed (see Table 2.4).

Table 2.4: Identification of typical farms

Group No.	Income [b]	Dimension Occupation	Production	No. of households[a]	Percentage
1	PCI < PL	Agriculture	Crop	51	15.50%
2	PCI < PL	Agriculture	Crop-Livestock	52	15.80%
3	PCI < PL	Mixed	Crop	31	9.40%
4	PCI < PL	Mixed	Crop-Livestock	30	9.10%
5	PCI ≥ PL	Agriculture	Crop	36	10.90%
6	PCI ≥ PL	Agriculture	Crop-Livestock	60	18.20%
7	PCI ≥ PL	Mixed	Crop	31	9.40%
8	PCI ≥ PL	Mixed	Crop-Livestock	38	11.60%
Total				329	100%

Note: [a] To accommodate organizational constraints, 8 households were randomly selected for each group of typical farm resulting in a total of 64 selected households. [b] PCI = per capita income. PL = poverty line.

Source: DFGFOR756 survey (2007)

To accommodate geographical and organizational constraints, a simple random selection process was next applied to draw a final selection 64 households in 7 sub-districts, of which two villages each, corresponding to 8 households per group for in-depth data collection.

The in-depth panel survey made use of a separate household questionnaire which was developed based on fundamental information provided by the base panel survey. In particular, the in-depth questionnaire focuses in details on household's farming and other income-generating activities, resource capacity, responses to recent market fluctuation as well as shock experiences and coping strategies in four different sections:

(i) Comprehensive agricultural production: cropping calendar with respective farming activity, amount and cost of input uses in every step of farming activity, household labors, yield and its disposition. Similar information was obtained for livestock and livestock products.

(ii) Off-farm and non-farm employment and availability of household labor for each income-generating activity.

(iii) Household's actual adjustments on cropping portfolio and input use to the recent price fluctuation.

(iv) Extensive shock-coping information: specific information about nature, timing, implementation and effects of shocks and coping strategies.

In order to generate comprehensive data concerning farm planning, production process and yield within one year and to facilitate data recalling, the first in-depth survey was undertaken at the beginning of the rice cropping cycle and immediately after the second base panel survey between 15th May – 1st June 2008 (see Table 2.3). The first in-depth survey share the same 12-month reference period as the second base panel survey (May 2007– April 2008). The second wave in-depth survey followed-up after the rice harvesting between 8th –29th January 2009 and relay the 12-month reference period to 1st January – 31st December 2008[18]. The in-depth panel survey in both waves were organized and implemented by the author with assistance from the Faculty of Agriculture, Ubon Ratchathani University. A team of three local enumerators (Bachelor or Master Degree graduates from the Faculty of Agriculture) were personally recruited and intensively trained by the author prior to the survey in both waves. The enumerators fulfilled the criteria of mastering the local dialect as well as having a solid background in agriculture. Similar to the base panel survey, the process of data editing and data entry was carried out directly during the survey by the author.

[18] In the second in-depth panel survey, the shock section applied a separate reference period referring to incidences and coping strategies between 2002 and 2008.

2.4 Descriptive results of the sample

This section gives an overview of preliminary results of sampled households in the study area. Fundamental aspects of households in base panel survey as well as in-depth panel survey are highlighted and prepared for the subsequent analyses in the following chapter 3 – 5. Since the descriptive results from both survey years give similar picture, the results presented here are based on the data collected from the 2nd base panel survey to focus on the most recent characteristics and shock situations of households that responded in both waves[19].

2.4.1 Base panel survey

Table 2.5 summarizes socio-demographic, economic, shock experience and village characteristics in 2007/2008 of 799 households in Buriram, 950 households in Ubon Ratchathani and 387 households in Nakhon Phanom interviewed in both waves (see Table 2.2). Geographically, distance between villages and district town is rather large with an average of 20 minutes travel time but households have a better access to markets with shorter travel time. According to the village heads, agriculture is the major source of employment for the villagers in all three provinces.

On average, households in all three provinces consist of 4 members and 2 migrant members living in other locations. About 70% of household heads are male and share similar average age of 54-56 years. Household education level is rather low with only basic primary school attainment for household heads and its members. With relatively high proportion of dependent members (aged below 15 and above 64), a large burden is borne by the independent working-age members. Agriculture is the major occupation of at least half of all working household members while the other half engage in off-farm and non-farm employment. Average size of owned landholdings is roughly larger than 2 ha of which most part is allocated to agricultural activity[20]. Except in Nakhon Phanom, households acquired additional land area for agricultural purposes through other form of land ownership.

Agriculture is one of the most important sources of income for rural households in the areas. In particular income from crop production represents a significant share of household income. Off-farm wage employment and non-farm self-employment are other major sources of income especially for households in Ubon Ratchathani and Nakhon Phanom. Migrant members also significantly contribute to household income through remittances especially in Nakhon Phanom where remittances received are even larger than income from crop production. In total,

[19] Village characteristics are obtained from the first base panel survey (see section 2.3.1).

[20] The average farm size obtained from the base panel survey is somewhat smaller than the official provincial statistics presented in Table 2.1 probably due to different definition and compilation procedure applied by each survey.

households in Ubon Ratchathani enjoyed highest household annual income among the three provinces but the highest monthly income per capita is observed in Buriram.

Furthermore, the data show that all households had experienced more than one shock incidence during the last 12-months. Almost every household in the provinces was frequently affected by covariate shocks of flood and drought whereas illness and death of household members were reported as most common idiosyncratic, i.e. household-specific shocks. On average, shocks had led to greater loss in income than in assets and households subjectively assessed these shocks to have medium to high severity on their well-being.

Household characteristics computed from the base surveys show that the majority of households experience shocks in the recent past which impose negative consequences on households' well-being. This preliminary finding urges for an extensive investigation of *ex-post* shock-coping situations among rural households which will be explored in chapter 3 (see specific research objective (I)). Furthermore, it is necessary to extend the research perspective to emphasize on anticipated future risk events perceived as threatening and relevant by the households and how they *ex-ante* mitigation these risks (see specific research objective (II)). This aspect is analyzed in chapter 4 and additionally offers a cross-country comparison with the three Vietnamese provinces: Dak Lak, Ha Tinh and Thua Thien Hue, as a joint work with Marc Völker, Institute of Development and Agricultural Economics, Gottfried Wilhelm Leibniz University of Hannover.

Table 2.5: Household characteristics in the study area 2007/2008

		Buriram N = 799		Ubon Ratchathani N = 950		Nakhon Phanom N = 387	
Socio-demographic		Mean	*Std. Err.*	Mean	*Std. Err.*	Mean	*Std. Err.*
Household size	*(persons)*	4.0	*1.7*	4.1	*1.8*	3.9	*1.6*
Age of household head	*(years)*	56.4	*13.1*	55.4	*13.3*	54.3	*12.7*
Education of household head	*(years)*	4.6	*3.0*	5.3	*3.1*	4.8	*2.6*
Education of household member	*(years)*	5.1	*2.2*	5.6	*2.4*	5.3	*2.1*
Gender of household head (Male)	*(%)*	74.2	*43.8*	73.9	*44.0*	69.0	*46.3*
Number of migrant members	*(persons)*	2.4	*3.3*	1.9	*1.2*	1.9	*1.9*
Dependency ratio[1)]	*(%)*	72.8	*74.6*	65.9	*69.4*	65.5	*66.1*
Agricultural occupation	*(%)*	45.4	*30.1*	45.9	*31.7*	50.0	*29.6*
Total owned land area	*(ha)*	2.24	*3.86*	2.55	*3.04*	2.15	*2.15*
Land used for agriculture	*(ha)*	2.74	*2.97*	2.68	*2.86*	1.99	*2.04*
Economic							
Crop production	*(PPP$)*	1864.8	*6421.1*	1956.0	*6802.3*	748.8	*2048.8*
Livestock and livestock product		226.0	*1325.3*	311.1	*1749.2*	259.8	*1272.2*
Natural resource extraction		126.5	*286.4*	308.2	*938.1*	248.3	*776.7*
Off-farm wage employment		1392.3	*3844.4*	2247.8	*6062.7*	1293.2	*2800.1*
Non-farm self-employment		1310.9	*8996.7*	1678.0	*11625.2*	795.9	*3571.3*
Savings		677.6	*2248.9*	1169.8	*3331.7*	912.6	*2711.1*
Public transfers		295.61	*1819.06*	196.86	*1141.67*	111.52	*246.29*
Remittances from migrant members		881.7	*2327.5*	488.8	*1504.6*	1088.0	*3006.2*
Remittances from friends/relatives		621.8	*6747.7*	309.5	*956.0*	136.0	*894.7*
Land rent		91.3	*910.5*	77.4	*327.6*	21.1	*122.6*
House and homestead		1280.1	*1750.9*	930.0	*1277.3*	1110.0	*1369.1*
Depreciation of productive assets		-779.4	*3754.6*	-750.6	*1786.8*	-493.4	*1476.0*
Loan interest payments		-318.5	*1359.7*	-275.2	*1287.5*	-131.8	*510.2*
Indemnity payments		181.6	*2420.6*	17.7	*229.6*	87.2	*692.0*
Total income		7896.7	*15278.6*	8215.9	*15138.1*	5708.2	*6355.2*
Monthly income per capita		198.0	*477.9*	185.0	*304.1*	136.0	*155.6*
Shock experience							
Shock incidences	*(numbers)*	1.3	*1.4*	1.7	*1.6*	1.6	*1.5*
Income loss from shocks	*(PPP$)*	1715.8	*4066.9*	791.2	*1896.0*	554.3	*1404.2*
Asset loss from shocks	*(PPP$)*	217.19	*1237.50*	332.31	*1979.34*	287.54	*995.59*
Shock severity[2)]	*(Scale)*	2.7	*0.4*	2.3	*0.6*	2.4	*0.6*
Village characteristics[3)]							
Time to district town	*(Minutes)*	24.5	*12.5*	20.7	*11.4*	19.2	*16.0*
Time to next market	*(Minutes)*	24.5	*12.5*	7.9	*9.6*	16.7	*15.7*
Agricultural employment	*(%)*	97.56	-	94.9	-	100.0	-

Note: [1)] Dependency ratio gives a proportion of household size relative to its independent members aged between 15-64 years.
[2)] Shock severity is a subjective assessment based on scale: 1 - low, 2 - medium, 3 - high. [3)] Village characteristics are obtained from the first base panel survey (2007).
Source: DFGFOR756 survey (2008).

2.4.2 In-depth panel survey

Characteristics of sub-sample 64 households for the in-depth panel survey are presented in Table 2.6 which compares the same household characteristics among the 8 groups of typical households in Ubon Ratchathani from the second base panel survey with the sample size of 8 households for each group. At the onset, all sampled villages rely on agriculture as the major employment sector but the villagers need to travel 5-10 minutes longer than the base population to reach the district town. Regarding market access, group 2 ("agricultural" income poor and vulnerable farm households with dual agricultural production systems of cropping and livestock) can reach the next market within 4 minutes as compared to at least 10 minutes for the other groups. In terms of socio-demographic characteristics, group 2 has the largest household size and the highest number of migrant members among the groups. Furthermore, group 2 has not only the oldest household heads but the education level of the head and their members are the lowest. It is worthwhile to note that group 1 and group 2 who are poor and mainly engage in agriculture are more often led by female heads than the other groups of higher-income or mixed occupation which are male-dominant (group 3 to 8). Apart from group 3 and group 7 (mixed occupation, cropping) who own the smallest land area of barely 1 ha, the other groups 2, 4, 6 and 8 (agricultural and mixed occupation with dual crop-livestock production) own larger landholdings of quite similar 2 ha. However, additional land acquirement through other forms of entitlement for agricultural purposes is prevalent for all groups except group 8.

Although all groups have a certain degree of on-farm and off-farm/non-farm activity combination, agricultural production is the main income source for the group 1, 2, 5 and 6 while the "mixed occupation" groups rely more on off-farm and non-farm self employment. In general, diversification of income source brings about higher income as "mixed-occupation" households have higher income than "agricultural" households and households who also raise livestock receive higher income than cropping-households. While group 8 receives the highest annual household income and scores highest for monthly per capita income, group 2 and 3 only earn half as much and represent the poorest of all groups.

Shock situation is more prevalent for the sub-sampled households from in-depth survey than the base population as the average shock incidence frequency is 2 to 3 shocks per household as compared to 1 to 2 shocks per household (see Table 2.5). Average income and asset loss from shocks, however, are comparatively lower than the shock losses experienced by the households in the base panel survey. All groups subjectively assessed the severity of shock events to be at least medium. Cross-group comparison shows that group 2 and 4 suffered most from shock while group 7 and 8 suffered the least.

Table 2.6: Characteristics of typical farm households in Ubon Ratchathani 2007/2008

		Group 1 N = 8		Group 2 N = 8		Group 3 N = 8		Group 4 N = 8		Group 5 N = 8		Group 6 N = 8		Group 7 N = 8		Group 8 N = 8	
Socio-demographic		Mean	*Std. Err.*	Mean	*Std. Err.*	Mean	*Std. Err.*	Mean	*Std. Err.*	Mean	*Std. Err.*	Mean	*Std. Err.*	Mean	*Std. Err.*	Mean	*Std. Err.*
Household nucleus size	*(persons)*	4.1	*1.1*	5.3	*1.7*	5.1	*1.2*	3.9	*1.4*	3.4	*0.9*	4.1	*1.4*	4.9	*1.8*	4.8	*0.9*
Age of household head	*(years)*	50.4	*16.2*	58.9	*11.2*	49.9	*15.1*	50.3	*10.6*	51.6	*17.3*	58.3	*14.9*	57.3	*11.3*	48.9	*5.9*
Education of household head	*(years)*	5.5	*2.8*	4.3	*0.7*	5.5	*2.8*	6.8	*3.4*	5.5	*1.9*	4.8	*2.1*	5.0	*2.1*	4.5	*0.9*
Education of household member	*(years)*	4.3	*1.3*	5.1	*2.4*	5.8	*1.5*	7.4	*1.6*	5.0	*1.3*	5.0	*1.8*	5.6	*1.5*	5.6	*1.2*
Gender of household head (Male)	*(%)*	0.6	*0.5*	0.6	*0.5*	0.9	*0.4*	0.9	*0.4*	0.9	*0.4*	0.9	*0.4*	0.9	*0.4*	0.8	*0.5*
Number of migrant members	*(persons)*	1.1	*0.6*	2.4	*1.7*	2.0	*1.7*	1.8	*1.2*	1.8	*0.9*	2.4	*0.9*	1.8	*0.7*	1.9	*0.8*
Dependency ratio[1)]	*(%)*	2.1	*0.6*	1.8	*0.4*	1.7	*0.5*	1.4	*0.4*	1.9	*1.0*	2.5	*1.7*	1.6	*0.4*	1.5	*0.5*
Agricultural occupation	*(%)*	0.56	*0.24*	0.56	*0.13*	0.42	*0.19*	0.54	*0.17*	0.40	*0.28*	0.63	*0.26*	0.57	*0.23*	0.49	*0.21*
Total owned land area	*(ha)*	1.89	*2.08*	2.15	*1.36*	0.64	*0.80*	2.35	*2.74*	1.78	*1.50*	2.52	*3.32*	1.35	*1.43*	2.18	*2.45*
Land used for agriculture	*(ha)*	2.20	*2.03*	2.65	*1.58*	1.38	*1.18*	4.08	*2.74*	2.50	*1.46*	2.47	*2.70*	1.52	*1.34*	2.05	*2.22*
Economic																	
Crop production	*(PPP$)*	1066.91	*954.01*	1329.86	*864.34*	771.99	*837.49*	2700.74	*3843.31*	2345.37	*1692.46*	2014.93	*2194.69*	980.50	*926.70*	3313.55	*6686.78*
Livestock and livestock product		-136.05	*395.31*	373.62	*308.73*	23.71	*31.82*	31.06	*871.95*	-57.40	*323.51*	940.18	*1513.44*	79.31	*117.89*	1090.02	*2166.92*
Natural resource extraction		292.50	*607.48*	220.46	*289.75*	136.98	*171.00*	262.51	*275.31*	304.46	*356.74*	581.47	*1245.26*	299.34	*562.47*	176.91	*190.84*
Off-farm wage employment		66.63	*146.85*	1122.18	*1616.80*	1558.40	*2872.14*	989.37	*1799.52*	708.50	*985.68*	926.03	*2064.67*	2254.90	*3230.97*	1102.10	*1385.30*
Non-farm self-employment		-	-	71.30	*201.65*	395.03	*764.91*	1113.37	*2942.25*	52.38	*148.15*	-	-	341.27	*595.27*	500.45	*728.94*
Savings		281.34	*601.75*	346.37	*255.10*	3184.27	*8131.17*	617.76	*1107.05*	1077.06	*1933.38*	862.53	*1224.83*	119.16	*202.63*	398.22	*683.81*
Public transfers		49.83	*121.06*	119.94	*152.72*	39.65	*70.46*	56.38	*122.11*	156.41	*169.80*	143.32	*242.13*	50.20	*122.20*	49.47	*121.60*
Remittances from migrant members		520.16	*731.30*	192.79	*533.62*	298.28	*387.85*	58.20	*164.61*	189.15	*362.46*	116.40	*262.13*	109.13	*308.65*	461.96	*843.46*
Remittances from friends/relatives		451.05	*1053.01*	254.63	*430.99*	519.07	*1287.64*	448.50	*1005.17*	213.16	*488.81*	422.68	*766.21*	457.31	*1150.29*	89.48	*223.05*
Land rent		-	-	-	-	-	-	-	-	-	-	153.32	*233.57*	-	-	-	-
House and homestead		698.40	*304.81*	640.20	*544.54*	1347.33	*3224.87*	651.84	*428.18*	314.28	*320.41*	1065.06	*659.13*	302.64	*270.35*	465.60	*350.20*
Depreciation of productive assets		-271.30	*216.80*	-480.59	*445.29*	-1190.75	*2780.18*	-739.05	*787.78*	-301.43	*332.59*	-339.50	*164.17*	-282.58	*219.57*	-400.16	*297.26*
Loan interest payments		-105.99	*139.68*	-228.81	*386.89*	-482.28	*1136.16*	-137.54	*148.74*	-528.31	*616.91*	-254.84	*544.86*	-136.33	*188.86*	-112.62	*134.65*
Indemnity payments		727.50	*2057.68*	-	-	-	-	-	-	-	-	58.20	*164.61*	-	-	-	-
Total income		3506.85	*3095.82*	3999.66	*2331.46*	3877.95	*3549.60*	5803.46	*7631.12*	3617.62	*1701.84*	6006.80	*3409.19*	4660.19	*2886.53*	7136.11	*7650.79*
Income per capita		71.37	*53.48*	67.19	*42.37*	60.09	*50.87*	108.49	*97.91*	89.13	*40.22*	134.87	*97.95*	81.29	*37.93*	126.61	*119.26*
Shock experience																	
Shock incidences	*(numbers)*	2.6	*1.5*	2.0	*1.6*	2.0	*2.6*	2.1	*1.5*	2.0	*1.9*	2.9	*2.0*	1.8	*1.6*	2.9	*1.6*
Income loss from shocks	*(PPP$)*	407.4	*593.5*	814.5	*954.2*	582.0	*1164.0*	1180.3	*1581.9*	710.9	*850.4*	436.1	*559.0*	281.7	*266.2*	242.5	*466.2*
Asset loss from shocks	*(PPP$)*	218.3	*617.3*	249.4	*659.9*	14.6	*29.1*	1940.0	*4752.0*	0.0	*0.0*	101.9	*288.1*	34.9	*52.1*	388.0	*950.4*
Shock severity[2)]	*(scale)*	2.7	*0.4*	2.6	*0.4*	2.4	*0.5*	2.3	*0.3*	2.4	*0.7*	2.0	*0.7*	2.5	*0.5*	2.5	*0.4*
Village characteristics[3)]																	
Time to district town	*(Minutes)*	30.6	*13.2*	27.9	*12.8*	30.4	*19.5*	22.5	*6.1*	26.0	*11.4*	25.4	*12.3*	25.0	*6.3*	28.6	*6.9*
Time to next market	*(Minutes)*	12.3	*19.6*	4.0	*3.0*	16.5	*23.8*	10.7	*11.6*	12.8	*14.1*	12.0	*13.7*	10.8	*13.1*	10.0	*11.1*
Agricultural employment	*(%)*	100		100		100		100		100		100		100		100	

[1)] Dependency ratio gives a proportion of household size relative to its independent members aged between 15-64 years. [2)]Shock severity is a subjective assessment based on scale: 1 - low, 2 - medium, 3 - high.
[3)] Village characteristics are obtained from the first base panel survey (2006).
Group 1 (PCI < PL, Agriculture, Crop); Group 2 (PCI < PL, Agriculture, Crop-Livestock); Group 3 (PCI < PL, Mixed occupation, Crop); Group 4 (PCI < PL, Mixed occupation, Crop-Livestock); Group 5 (PCI = PL, Agriculture, Crop); Group 6 (PCI = PL, Agriculture, Crop-Livestock); Group 7 (PCI = PL, Mixed occupation, Crop); Group 8 (PCI = PL, Mixed occupation, Crop-Livestock)
PCI = per capita income; PL = poverty line. Source: DFGFOR756 survey (2008).

Table 2.7 provides more details about major income-generating activities of the eight different typical farm households. In terms of agriculture, jasmine rice (primary for sale) and glutinous rice (primarily for subsistence consumption) are the most important crops which are commonly cultivated by all households. A number of households also grow home vegetables in the backyard mainly for subsistence consumption, and cassava has received more attention during the last years as a complementary cash-crop. Chicken is raised by all households for subsistence consumption while buffalo and beef cattle are raised mainly for commercial purpose. Note that although all households engage to a certain degree in livestock production, group 2, 4, 6 and 8 are more specialized in this area than other crop-households. Construction and service work are the most common off-farm wage employment for all groups while group 7 and 8 extend their income portfolio to cover non-farm self-employment business such as retail shop, petty trader and handicraft. Natural resource extraction especially collecting and fishing represents significant additional income-generating activities for all groups.

Table 2.7: Income-generating activities of typical farm households in Ubon Ratchathani 2007/2008

	Group 1 N = 8	Group 2 N = 8	Group 3 N = 8	Group 4 N = 8	Group 5 N = 8	Group 6 N = 8	Group 7 N = 8	Group 8 N = 8
Agriculture (%)								
Jasmine rice	75.0	50.0	50.0	87.5	62.5	62.5	37.5	50.0
Glutinous rice	75.0	87.5	100.0	100.0	100.0	75.0	75.0	87.5
Non-fragrant rice	-	25.0	-	-	-	-	-	12.5
Home vegetable	12.5	25.0	-	25.0	12.5	25.0	12.5	25.0
Cassava	-	12.5	-	25.0	-	12.5	-	-
Fruit	-	-	-	-	12.5	-	12.5	-
Cattle	25.0	87.5	-	50.0	-	25.0	-	-
Buffalo	25.0	50.0	12.5	37.5	37.5	50.0	25.0	75.0
Chicken	50.0	100.0	62.5	75.0	50.0	62.5	62.5	62.5
Off-farm employment (%)								
Agriculture wage labour	-	37.5	37.5	25.0	-	25.0	12.5	12.5
Machinery	-	-	-	-	25.0	100.0	12.5	12.5
Industrial worker	12.5	12.5	12.5	-	12.5	-	12.5	37.5
Construction work	62.5	50.0	50.0	12.5	25.0	37.5	25.0	12.5
Service	37.5	12.5	25.0	25.0	37.5	25.0	25.0	12.5
Non-farm self-employment (%)								
Retail shop	-	12.5	12.5	-	-	-	12.5	25.0
Petty trader	-	-	12.5	12.5	-	-	12.5	12.5
Handicraft	-	-	-	-	-	-	12.5	12.5
Natural resource extraction (%)								
Fishing	71.4	87.5	83.3	50.0	80.0	87.5	71.4	75.0
Collecting	57.1	100.0	66.7	75.0	100.0	100.0	71.4	75.0
Logging	42.9	37.5	66.7	62.5	60.0	37.5	42.9	50.0

Source: DFGFOR756 survey (2008).

By and large, descriptive results of typical farm comparison suggest that group 2 ("agricultural" income poor and vulnerable farm households with dual agricultural production systems of cropping and livestock) features characteristics that are particularly suitable for a vulnerability analysis of farm households. To clearly elaborate on the impact of the food and input price shocks in 2008 on adjustment behavior and vulnerability to poverty of rural farm households (see specific research objective (III)), this group will be the focus of the analysis carried out in chapter 5.

2.5 Summary and conclusion

To prepare the data scope required for research objectives focused in this study as specified in chapter 1, a comprehensive household database is generated from two complementary household surveys: two-period base panel survey and two-period in-depth panel survey. While the base panel survey aims to cover broad household information, the in-depth panel survey from the sub-sample provides additional data regarding detailed production process and consumption aspects including household resource capacity. In April-May 2007 and 2008, the base panel survey interviewed a total of about 2,200 representative households in three Northeastern Thai provinces (Ubon Ratchathani, Buriram and Nakhon Phanom). These households were selected through the 3-stage stratified cluster sampling approach based on their characteristics suitable for vulnerability to poverty of rural farm household studies. Primary data obtained from two base panel surveys include household composition and household dynamics, shock experiences and risk perception of threatening events in the future, portfolios of income-generating activities such as agriculture, off-farm and non-farm self-employment, financial situation (e.g. lending, borrowing and savings), household expenditures, assets and location (i.e. village) characteristics. The collected information, especially the shock incidences and *ex-post* coping strategies as well as perception of risk and *ex-ante* mitigation actions, constitute an essential element of the stochastic component in vulnerability to poverty analysis.

As shown by the preliminary descriptive results, the majority of households experience shocks during the past years which have considerable adverse affects on households' income, asset and overall subjective well-being. In chapter 3 common types of shocks and corresponding *ex-post* coping measures are identified and the factors determining coping behavior are explored. Chapter 4 extends the perspective to capture the interrelation between households' shock experience with their subjective perception of future risk events and corresponding *ex-ante* risk mitigation strategies. The analysis in chapter 4 emphasizes on weather-related events and compares the results of rural households in Thailand and Vietnam.

In addition to household data collected from the base panel survey, there was a need to acquire supplementary information to allow a more precise modeling of household behavior. Therefore an in-depth panel survey was conducted to gather details regarding technical production processes typical for the research area as well as resource constraints that can represent the decision making behavior of "typical farm households". Following a two-step ad-hoc filter and identification approach that ensures agricultural and vulnerability to poverty aspects, a sub-sample of 64 households were purposively drawn from the original pool of households in Ubon Ratchathani province to identify 8 different groups of typical farm households. The additional information was necessary to set up a suitable farm household model based on one of the 8 groups of typical farms that allow the analysis of external price shocks impact on households' response behavior and vulnerability to poverty. Based on the households and production characteristics of all 8 typical farm groups, group 2 (i.e. "agricultural" income poor and vulnerable farm households with dual agricultural production systems of cropping and livestock) is on average one of the poorest with the lowest household income, high shock severity, largest household size, highest number of migrant members, oldest household head and lowest education level. Hence, group 2 was chosen as an example case and the detailed dataset collected from in-depth survey was used to construct the typical farm model by means of mathematical programming to test the new approach of vulnerability to poverty assessment specifically elaborated in chapter 5. For a realistic behavioral modeling, the farm household model partly incorporates the weather-related shock incidences and subjective risk perception of these events, provided by the base panel survey, to embed in the decision-making and the adjustment process.

The household data collected from the base panel survey and the additional in-depth panel survey generate a unique and comprehensive database for the purpose of vulnerability to poverty analysis. Nonetheless, several cautions should be taken into account regarding result interpretation. First, the data contains information on shock experience during the reference period from 2002 to 2008 only, i.e. any possible prevailing effects from shocks before 2002 cannot be excluded. Second, the analyses throughout this study focus on the cross-section household situation in each reference period of attention, i.e. the recursive characteristic of household data between each successive period is not accounted for. Third, the econometric models in chapter 4 and the mathematical programming model in chapter 5 use data on subjective risk perception obtained from the interviewed household members, i.e. household heads in most cases. This information represents the subjective risk perception of an individual household member which is assumed to influence the decision-making behavior of the collective household unit. Finally, information on biological aspects of agricultural production (e.g. soil quality and fertilizer nutrition), historical statistical data on weather-related events (e.g.

quantity of rainfall), and key market indicators (e.g. market price of major commodities) are not part of the available dataset. Acquiring such additional information may enhance the data quality and further improve the analyses.

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Chapter 3

Shocks and *ex-post* Coping Strategies of Rural Households

3.1 Introduction

Despite high rates of economic growth in emerging market economies such as Thailand, poverty 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). Living in risky environment, rural households apply different *ex-ante* risk management strategies such as income diversification or asset accumulation. However, shocks or unexpected negative events still occur and cause serious reduction in income and consumption which may drive households toward poverty. Understanding shocks and their consequences is essential for the design of effective poverty alleviation strategies. The literature on vulnerability to poverty suggests that shock-coping activities are not independent of shock type and household characteristics (e.g. Hoddinott 2006, Rashid et al. 2006, Dercon 2007, Berloffa and Modena 2009). However, there is a need to further explore this interaction on strong empirical grounds, which is only possible with a comprehensive empirical data set. 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 analyze the effects of common shocks on income and assets of rural households and to assess their behavior regarding decisions to take coping action and the choice of coping measures.

To better understand the effects of shocks and choices of coping activities, four broad categories of shocks are defined in this study namely agricultural, economic, health and social shocks (Klasen et al. 2010). Agricultural shocks[21] refer to shocks caused by adverse weather conditions and other events of nature such as flooding, landslides, storms, drought, crop pests, and livestock diseases. Economic shocks include price shocks[22], job loss and collapse of own

[21] The term "agricultural shock" has been commonly used in the literature. Generally these are weather-related shocks which however can also affect non-agricultural households, for example when houses are damaged by storm or flood.

[22] This includes prices of agricultural commodities and prices of inputs.

business, credit problems, and termination of remittances from absent family members, relatives or friends. Illness or accidents of household members as well as death and birth are categorized under health shocks. Lastly, social obligation such as money spent on ceremony, theft, conflicts with neighbors, divorce or imprisonment of household members fall into the category of social shocks.

To identify types and effects of shocks and to analyze *ex-post* coping behavior of the households in three provinces in Northeast Thailand (specific research objective (I)), the panel data collected from a sample of about 2,200 rural households in Ubon Ratchathani, Buriram and Nakhon Phanom provinces provides information that can help to answer the following four research questions, dealt with in this chapter:

(i) What are the major shocks that rural households face?

(ii) What *ex-post* coping measures are generally used?

(iii) What are the reasons that some households undertake *ex-post* coping actions in response to shocks while others do not?

(iv) Which factors determine the choice of a specific *ex-post* coping activity?

To address the research questions outlined above, this chapter is organized as followed. Section 3.2 shortly reviews the literature on factors that are believed to influence the *ex-post* coping actions and presents the selected variables used in the subsequent analyses. Section 3.3 addresses the research questions (i) and (ii) by discussing major shocks and the corresponding *ex-post* coping responses of rural households in the three provinces from the two panel waves. Following these descriptive analyses, section 3.4 introduces two analytical models. The first approach helps to explain the reasons why some households do undertake coping actions while others do not (research question (iii)). The second model is used to explain the choice of specific coping actions (research question (iv)). Section 3.5 summarizes the empirical findings and offers some policy conclusions.

3.2 Conceptual framework

In the literature a distinction is made between idiosyncratic (i.e. individual household-specific) 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). Effects of shocks are translated into income loss, which can put financial constraints on households and can lead to asset loss that may decrease future earning possibilities and savings. Since the majority of rural households engage in agricultural production, they are particularly prone to agricultural shocks, e.g. drought and

flooding which cause damage on yield and value of agricultural output and in turn reduce household income (Asiimwe and Mpuga 2007, Pandey et al. 2007, Tongruksawatttana et al. 2008). The adverse effect of shocks is generally more severe for the poor who are less *ex-ante* insured against shocks than wealthier households (Jalan and Ravallion 1999). At the same time, poor rural households are also more likely to experience health shocks such as illness and death of a household member than wealthier households (Tongruksawattana et al. 2008, Heltberg and Lund 2009). In some circumstances, these households are even more fragile to health shocks than to agricultural shocks (Kochar 1995).

Concerning responses to shocks, existing studies show that households do not randomly select coping activities but follow some structure that takes types of shocks and household resources into account (e.g. Watts 1983, 1988, Cutler 1986, Frankenberger 1992). In general, households who face sudden income or asset loss try to compensate for the loss and attempt to earn additional income and/or reduce savings. As found by Rashid et al. (2006), the choice of coping actions of rural households in Bangladesh depends on the type of shocks as well as household characteristics, asset, the diversity and stability of household income sources. Other authors (e.g. Kochar 1999, Newhouse 2005) found that when households face agricultural income loss, they try to compensate through off-farm or non-farm employment, asset sales and borrowing. However, poor households have to rely on agricultural casual wage labor more than employment with regular salaries (Kijima et al. 2006). Another study on flood and health shocks of households in Amazonian tropical areas observed that coping responses are influenced by local environmental endowments and household asset holdings (Takasaki et al. 2002). For example, in coping with flood, a dominant coping activity was intensification of fishing efforts (Takasaki et al. 2010). 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 (Dercon 2007, Heltberg and Lund 2009). While households with higher levels of assets tend to use savings or take up additional loans to cope with income loss, poor households are more likely to work off-farm (Hoddinott 2006, Berloffa and Modena 2009). Carter and Maluccio (2002) pointed out the role of social capital as an important element of coping mechanisms. The coping possibility of a household for any shock is limited in a community where many households suffer from covariate shocks since mutual support from social network is restrained (Alderman and Paxson 1992).

Based on the literature, three groups of determinants can be identified to have influence on responses to shocks: (i) household characteristics, (ii) type of shock and shock severity, and (iii) location factors.

First, among household characteristics, five variables have been selected as potentially influential, namely income, wealth, education, occupation, and number of migrant members. For example, households with higher income and wealth status generally find it easier to compensate the losses from shocks and their recovery time is shorter (e.g. Glewwe and Gillette 1998, Cutter et al. 2003). Beyene (2008) showed that higher education levels enable access to more qualified jobs in the non-farm economy and better access to information on the possibilities to mitigate shocks such as the availability of public support programs. The demographic situation of a household like the share of household members engaged in agriculture and the number of migrant household members is important for the coping capacity for shocks. Migration affects the age structure of a household with younger and older people left behind which can reduce their coping capability. On the other hand, migration is generally associated with remittances which can reduce the negative effect of shocks.

Type and severity of shocks are the second major determinants of coping actions. Type is classified in the four categories agriculture, economic, health, and social as explained in section 3.1. Severity was captured in two different dimensions. The first dimension measures shock severity as respondents' assessment of income or asset loss caused by a shock, converted to per capita data. This is reasonable because households are confronted with direct damage costs as well as mitigation costs and, in some cases, costs of *ex-ante* risk management and prevention in order to reduce the impact of future risks. The second dimension assesses the overall level of shock severity perceived by the households as subjective severity estimation categorized in four degrees: high, medium, low or no impact.

The third group of determinants includes location factors such as traveling distance between the village and the provincial capital as well as access to market measured by traveling time. These conditions can enhance household's ability to cope. For example, if a provincial capital is easily reachable then a larger labor market may facilitate the access to off-farm and non-farm jobs. At the same time a nearby town can possibly provide easier access to a market in order to compensate for the smaller size or the lack of own village market (Beyene 2008). However, regional characteristics can also hamper households' abilities to cope, i.e. if a region is heavily dependent on one economic sector, opportunities can turn into constraints in case of economic crisis (Cutter et al. 2003).

3.3 Shock incidences and coping responses

Based on household data from panel base survey in 2007 and 2008 as described in chapter 2, this section provides insight into the general importance of shocks, shock types, and the corresponding responses to shocks of rural households in the three provinces in Thailand. For

the purpose of this study, all shocks with at least low subjective severity[23] that occurred during the first reference period (January 2006 - April 2007) applied in the 1st panel base survey as well as during the second reference period (May 2007-April 2008) applied in the 2nd panel base survey are considered. The results are generated from a comparative static analysis of the two data sets to obtain a broader picture of shock situations and coping behaviors.

The overall situation of households with external shocks in both periods can be described by the proportion of households who reported at least one shock experience. Our data reveal 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 (see Table 3.1). The shock situation is quite different among the provinces, indicating that local factors play an important role and have to be taken into account in the models estimated in section 3.4. Moreover, looking at the number of shocks reported, our data clearly show that many households are affected by more than one shock in either of the periods, and the number of shocks per household significantly increased in all provinces in the 2nd period (see Table 3.1).

Table 3.1: Number of households and shock incidences

Province	1st wave (2007)			2nd wave (2008)		
	No. of surveyed households[1]	No. and % of households with shock experience[2]	No. of shocks per household	No. of surveyed households[1]	No. and % of households with shock experience[2]	No. of shocks per household
Buriram	796	180 (23)	1.14	788	443 (56)	1.64
Ubon Ratchathani	928	355 (38)	1.34	939	606 (65)	2.00
Nakhon Phanom	389	149 (38)	1.27	383	231 (60)	1.96
Total	2113	684 (32)	1.27	2110	1280 (61)	1.87

[1] Some households were removed in each survey period from the analysis due to incomplete data.
[2] Percentages are shown in parentheses
Source: DFGFOR756 survey (2007) and (2008)

The relative importance of the four groups of shocks as defined in section 3.1 are identified and measured in terms of frequencies. Table 3.2 summarizes the type of shock incidences as percentage of affected households in the three provinces in both survey periods. Clearly agricultural shocks, especially those caused by flooding and drought, are the most common in this region in both years. This observation shows the same pattern as found in weather-related disaster surveys (e.g. World Bank 2005a). The twice increase in percentage of affected households from the 1st to the 2nd period (18.4% to 37.6%) illustrates the high volatility of weather conditions over time and the associated high sensitivity of rural households to agriculture-related incidences in all three provinces.

[23] In the shock-section of the questionnaire, respondents were asked whether there was any event causing a big problem (shock) affecting the household first, followed by a subjectively estimate of the severity, i.e. high, medium, low or no impact. Subsequently, they were asked to estimate the associated income and asset loss.

Health shocks, especially illness of a household member, represent the second most common shock type experienced by households. The fraction of affected households increased from 9.7% in the 1st wave to 23.6% in the 2nd wave, quite similar distributed among the provinces although somewhat less frequent in Buriram. Considering unfavorable 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. Lastly, crime and conflicts with others and social-related obligation such as spending on ceremony expenses represent another important social shock category.

Table 3.2: Shock incidences, by shock type and province

Province	No. of surveyed households	Shock type			
		No. and % of affected households[1]			
		Agricultural	Economic	Health	Social
1st wave					
Buriram	796	85 (10.7)	45 (5.7)	52 (6.5)	14 (1.8)
Ubon Ratchathani	928	213 (23.0)	62 (6.7)	111 (12.0)	30 (3.2)
Nakhon Panom	389	90 (23.1)	29 (7.5)	42 (10.8)	14 (3.6)
Total	2113	388 (18.4)	136 (6.4)	205 (9.7)	58 (2.7)
2nd wave					
Buriram	788	307 (39.0)	142 (18.0)	109 (13.8)	57 (7.2)
Ubon Ratchathani	939	353 (37.6)	205 (21.8)	285 (30.4)	107 (11.4)
Nakhon Panom	383	133 (34.7)	78 (20.4)	103 (26.9)	51 (13.3)
Total	2110	793 (37.6)	425 (20.1)	497 (23.6)	215 (10.2)

[1] Percentages are shown in parentheses.
Source: DFGFOR756 survey (2007) and (2008)

Based on these findings, we concentrate our descriptive analysis on households who experienced shocks in the respective periods. Table 3.3 characterized these households by means of variables that most likely to influence shock-coping strategies. The selected variables are grouped according to the three general determinants (household, shock, and village characteristics) derived in section 3.2. In order to assure exogeneity, the variable income per capita used in this analysis was defined as annual per capita income before shocks, and the variable wealth per capita was similarly defined as the sum of all annual productive and consumption assets including value of the house, own land, value of livestock and financial savings before shocks. Similarly, migration as coping strategy was explicitly specified as reaction to shocks.

A household generally comprises of 4 members with at least one migrant member living in other location. As shown in Table 3.3, compared to all households shock-affected households are poor as their average monthly per capita income (approximately PPP$ 36 in 1st wave and PPP$ 37.5 in

2nd wave) lie below regional poverty line[24]. Although households have quite large wealth accumulation per capita but a high disparity among the better and the worse-off can be observed. The highest education level attained in a household is secondary school. On average, shock-affected households equally allocate their labor between on-farm and off-farm employment. Furthermore, location characteristics show that average distance to the provincial capital is about 60 km but access to financial institution is quite poor as it takes about 15 minutes from the village to reach the next market. In Thailand, banks usually locate in the same area as market. Therefore, traveling time to the next market was considered to represent traveling time to the next bank and hence to capture access to credits.

Table 3.3: Shock-affected household characteristics

Variables	1st wave N = 684		2nd wave N = 1280	
	Mean	*Std.Dev.*	**Mean**	*Std.Dev.*
Household characteristics				
Annual income per capita before shock *(100 PPP$)* [a]	**21.6**	*24.0*	**22.5**	*38.1*
Annual wealth per capita before shock[c] *(100 PPP$)* [a]	**156.1**	*227.1*	**39.3**	*173.7*
Maximum years of schooling *(Years)*	**8.4**	*3.6*	**8.8**	*3.7*
Ratio of household members engaged in agriculture *(%)*	**0.5**	*0.3*	**0.5**	*0.3*
Number of migrant member *(Persons)*	**0.9**	*1.3*	**1.1**	*1.5*
Shock characteristics				
Income loss per capita				
Agricultural shock *(100 PPP$)* [a]	**1.5**	*3.0*	**1.8**	*5.4*
Economic shock *(100 PPP$)* [a]	**0.8**	*3.6*	**0.8**	*8.1*
Health shock *(100 PPP$)* [a]	**0.8**	*4.1*	**0.4**	*2.6*
Social shock *(100 PPP$)* [a]	**0.1**	*0.9*	**0.2**	*1.8*
All shock *(100 PPP$)* [a]	**3.2**	*6.0*	**3.1**	*10.6*
Asset loss per capita				
Agricultural shock *(100 PPP$)* [a]	**0.5**	*3.1*	**0.3**	*1.8*
Economic shock *(100 PPP$)* [a]	**0.9**	*5.3*	**0.1**	*1.4*
Health shock *(100 PPP$)* [a]	**1.0**	*5.0*	**0.3**	*2.9*
Social shock *(100 PPP$)* [a]	**0.5**	*3.2*	**0.2**	*2.3*
All shock *(100 PPP$)* [a]	**2.9**	*8.5*	**0.8**	*4.7*
Subjective severity				
Agricultural shock *(Scale: 1 - 3)* [b]	**2.5**	*0.6*	**2.5**	*0.6*
Economic shock *(Scale: 1 - 3)* [b]	**2.6**	*0.6*	**2.6**	*0.6*
Health shock *(Scale: 1 - 3)* [b]	**2.7**	*0.5*	**2.4**	*0.7*
Social shock *(Scale: 1 - 3)* [b]	**2.6**	*0.6*	**2.4**	*0.6*
All shock *(Scale: 1 - 3)* [b]	**2.6**	*0.6*	**2.5**	*0.6*
Village characteristics				
Distance from village to provincial capital *(Kilometer)*	**57.3**	*33.3*	**57.6**	*33.3*
Travelling time to the next market *(Minutes)*	**14.1**	*14.3*	**15.2**	*14.1*

[a] Measured in PPP$ (2005) with conversion factor for THB of 0.0600 (1st wave) and 0.0582 (2nd wave)
[b] Subjective shock severity is measured in ordinal scale: 3 = high severity; 2 = medium severity; 1 = low severity.
[c] Wealth is an asset-based variable comprises of the sum of all productive and consumption assets including value of the house, own land, value of livestock and financial savings.
Source: DFGFOR756 survey (2007) and (2008)

[24] Monthly income per capita poverty line in 2007 is equal to THB 1,316 or approximately PPP$ 76.59 in Northeast Thailand (NESDB)

In terms of monetary effects of shocks, on the one hand, shocks generally have stronger impact on income than on asset. The average income loss per capita in absolute terms and relative income loss proportional to the households' initial income terms remain almost constant in both periods (-14.8% and -13.7% in 1st and 2nd wave respectively, see Table 3.3)[25]. The loss of assets relative to the wealth before shocks draws a quite different picture. Despite a large asset loss reduction (-72%) from period 1 to period 2, there was a noteworthy increase of the proportional asset loss to household wealth before shocks from -1.8% to -4.1%. This is due to a sharp decrease in the wealth level of affected households from period 1 to period 2 (-11%). Comparing the effects of the four different types of shocks, agricultural (i.e. weather-related) shocks cause the highest average income loss per capita, accounting for roughly half of the income loss of all shocks followed by economic, health and social shocks, respectively. Referring to the asset losses, however, health shocks cause the highest asset loss in the 1st period, whereas agriculture and health shocks are of equal importance in the 2nd period. On the other hand, households subjectively assessed all shocks to have high and medium severity. In both periods, agricultural and economic shocks were evaluated with the same level of subjective severity whereas health and social shocks were perceived to have milder severity in the 2nd wave.

Figure 3.1 gives more insight to shock experience by income and wealth per capita distribution among the surveyed households in different quartiles. For both dimensions in both survey periods, agricultural shocks appear to affect all households similarly regardless of income and wealth level due to the covariate nature of this shock type. On the other hand, income and wealth poor households are more fragile to health shocks whereas economic and social shocks are a bigger burden for households in higher income and wealth quartiles.

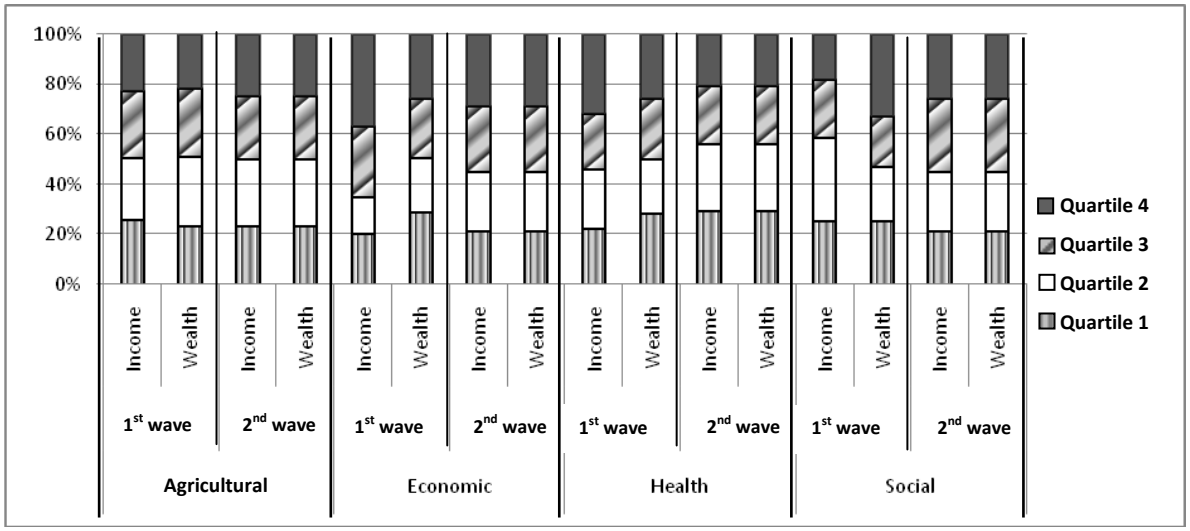

Figure 3.1: Relative shock frequency, by shock type, income and wealth per capita quartiles

Source: DFGFOR756 survey (2007) and (2008)

[25] However, income and wealth level of households might be influenced by shock incidents prior to the respective survey period and shock-affected households might differ between 1st and 2nd period.

As a next step, coping behavior as a response to different types of shocks in both countries and periods is analyzed. In this context, a coping action is defined as an explicit and active undertaking to counteract the negative shock effect as reported by the households. On the other hand, households are categorized as "do not cope" if they did nothing explicitly and directly to deal with any of the shocks due to various reasons mentioned above or if they responded to shocks in a passive way such as slightly reducing consumption.

As summarized in Table 3.4, the majority of shock incidents was treated with at least one coping action although more shock incidents were left "uncoped" during the 2nd period (70% and 51% in the 1st and 2nd wave respectively). Non-coping may result from, for example, no specific action available or low shock implications relative to net benefits involved from coping. In some cases, no special action may seem to be necessary, for example in the case of health problems which household may decide there is no need or chance to see a doctor. The phenomenon either to cope or to refrain from coping is more specifically addressed in section 3.4, Model 1. Concerning coping actions by shock type, observations in both periods show that health shocks often received more coping action than other shock types (see Table 3.4). Apart from health shocks, Thai households are more responsive to economic shocks and social shocks than to agricultural shocks although agricultural shocks was the most frequent and severe type of shock (as previously shown in Table 3.2).

Table 3.4: Percent of shocks where coping action is taken

Type of shock	Coping action (%)	
	1st wave n = 868	2nd wave n = 2390
Agricultural	58	31
Economic	80	62
Health	86	70
Social	68	63
Total	70	51

Note: n is the number of shock incidents (see Table 3.1)
Source: DFGFOR756 survey (2007) and (2008)

The underlying reasons that some households undertake coping actions in response to shocks while others do not (research question (iii)) may lie in the difference of household, shock and village characteristics between the two groups of households. With an exception for lower income loss from agricultural shocks, "cope" households generally suffered from larger income and asset loss and perceived overall subjective shock severity to be higher than "no-cope" counterparts for all types of shocks (see Table 3.5). For "cope" households, for example, income and asset loss from health shock is 3 and 13-times higher than "no-cope" households in the 1st period, respectively, while "no cope" households did not incur any asset loss due to this type of shock in the 2nd period. Furthermore, numbers of household members engaged in agriculture or

migrated as well as traveling time to the next market seem to be distinctive characteristics between the two groups of households. The influence of these variables on the decision to take a coping action will be explored in details in section 3.4 (Model 1).

Table 3.5: Characteristics of "Cope" and "No-Cope" households

Variable description	1st wave		2nd wave	
	"Cope" N = 514	"No cope" N = 170	"Cope" N = 814	"No cope" N = 466
	Mean *(Std. Dev.)*	**Mean** *(Std. Dev.)*	**Mean** *(Std. Dev.)*	**Mean** *(Std. Dev.)*
Household characteristics				
Annual income per capita before shock *(100 PPP$)* [a]	**21.9** *(24.2)*	**20.5** *(23.4)*	**23.7** *(43.3)*	**20.4** *(26.4)*
Annual wealth per capita before shock[c] *(100 PPP$)* [a]	**147.8** *(207.7)*	**181.1** *(276.9)*	**140.4** *(179.9)*	**137.3** *(162.3)*
Maximum years of schooling *(Years)*	**8.4** *(3.6)*	**8.6** *(3.7)*	**8.8** *(3.7)*	**8.6** *(3.8)*
Ratio of household members engaged in agriculture *(%)*	**0.5** *(0.3)*	**0.5** *(0.3)*	**0.5** *(0.3)*	**0.5** *(0.3)*
Number of migrant member *(Persons)*	**0.9** *(1.3)*	**0.8** *(1.1)*	**1.2** *(1.5)*	**1.0** *(1.3)*
Shock characteristics				
Income loss per capita				
Agricultural shock *(100 PPP$)* [a]	**1.4** *(3.1)*	**1.6** *(2.6)*	**1.5** *(4.1)*	**2.3** *(7.0)*
Economic shock *(100 PPP$)* [a]	**0.9** *(3.7)*	**0.5** *(3.3)*	**1.1** *(10.1)*	**0.3** *(1.5)*
Health shock *(100 PPP$)* [a]	**0.9** *4.5)*	**0.3** *(1.8)*	**0.5** *(3.2)*	**0.1** *(1.0)*
Social shock *(100 PPP$)* [a]	**0.1** *(1.1)*	**0.0** *(0.0)*	**0.2** *(2.2)*	**0.1** *(0.7)*
All shock *(100 PPP$)* [a]	**3.4** *(6.5)*	**2.3** *(4.4)*	**3.4** *(12.1)*	**2.8** *(7.3)*
Asset loss per capita				
Agricultural shock *(100 PPP$)* [a]	**0.6** *(3.5)*	**0.3** *(1.2)*	**0.4** *(2.2)*	**0.1** *(0.5)*
Economic shock *(100 PPP$)* [a]	**1.1** *(5.9)*	**0.3** *(2.7)*	**0.1** *(1.7)*	**0.0** *(0.0)*
Health shock *(100 PPP$)* [a]	**1.3** *(5.7)*	**0.1** *(0.9)*	**0.4** *(3.7)*	**0.0** *(0.1)*
Social shock *(100 PPP$)* [a]	**0.5** *(3.1)*	**0.4** *(3.5)*	**0.3** *(2.8)*	**0.1** *(1.0)*
All shock *(100 PPP$)* [a]	**3.4** *(9.3)*	**1.1** *(4.6)*	**1.2** *(5.8)*	**0.2** *(1.1)*
Subjective severity				
Agricultural shock *(Scale: 1 - 3)* [b]	**2.5** *(0.6)*	**2.5** *(0.6)*	**2.5** *(0.6)*	**2.5** *(0.6)*
Economic shock *(Scale: 1 - 3)* [b]	**2.6** *(0.6)*	**2.3** *(0.8)*	**2.6** *(0.6)*	**2.6** *(0.5)*
Health shock *(Scale: 1 - 3)* [b]	**2.7** *(0.5)*	**2.6** *(0.6)*	**2.4** *(0.7)*	**2.2** *(0.8)*
Social shock *(Scale: 1 - 3)* [b]	**2.6** *(0.5)*	**2.4** *(0.7)*	**2.4** *(0.6)*	**2.5** *(0.6)*
All shock *(Scale: 1 - 3)* [b]	**2.6** *(0.5)*	**2.5** *(0.7)*	**2.5** *(0.6)*	**2.4** *(0.6)*
Village characteristics				
Distance from village to provincial capital *(Kilometer)*	**58.0** *(32.8)*	**55.4** *(34.8)*	**58.8** *(34.3)*	**55.3** *(31.4)*
Travelling time to the next market *(Minutes)*	**14.1** *(14.0)*	**13.9** *(15.2)*	**13.4** *(13.5)*	**18.3** *(14.6)*

[a] Measured in PPP$ (2005) with conversion factor for THB of 0.0600 (1st wave) and 0.0582 (2nd wave)
[b] Subjective severity is measured in scale: 1 = high; 2 = medium; 3 = low.
[c] Wealth is an asset-based variable comprises of the sum of all productive and consumption assets including value of the house, own land, value of livestock and financial savings.
Source: DFGFOR756 survey (2007) and (2008)

In order to generate information on the coping behavior of households and to identify interrelations between shock types and specific coping actions, only shock-affected households who applied a coping action, i.e. "cope" households, are considered in the following.

The majority of households who undertook a coping action applied only one measure to cope with a shock although some households reported multiple measures simultaneously or consecutively. The coping activities reported by the households are categorized into four groups:

(i) "Remittances and transfers", i.e. taking up transfers and grants from public support schemes and asking for (additional) remittances from migrant members, relatives, friends and neighbors.

(ii) "Resource reallocation", i.e. reallocating household resources for additional income such as labor including off-farm/non-farm employment and temporary or permanent migration. In some cases children are taken out of school to work. Under this coping measure, household agricultural resources can be further adjusted such as crop substitution and reduction of production inputs.

(iii) "Borrowing", i.e. taking loans from formal and informal sources. In general, common institutions for formal lending are commercial banks, Bank for Agriculture and Agricultural Cooperatives (BAAC), village banks and cooperative banks. On the other hand, informal borrowing sources include relatives, friends, neighbors, private money lenders and village funds.

(iv) "Use savings and sell assets", i.e. households can draw on savings or sell their assets such as land or livestock for a prompt and large amount of cash.

Table 3.6 summarizes the relations between coping actions and the shock types in the two periods. The distribution of coping activities is presented as a percentage of all coping actions reported[26]. The calculated shares show some similarities and differences regarding coping behavior between the two survey periods. In the 1st wave, borrowing is the most frequent type of coping action accounting for 33% of all coping actions applied and the importance of borrowing remained high in the 2nd wave (22%). However, in the 2nd wave the most often applied coping action in Thailand is liquidation of savings and selling of assets (36%). In both periods, borrowing and using savings or selling assets are the most preferred coping measures for Thai households. This applies to all shock types, but especially to those related to health and social matters. This finding emphasizes the importance of access to credit to cope with shocks. The coping action less frequently applied is taking up of remittances from migrant household members, relatives, friends and neighbors as well as drawing on transfers from public programs.

With respect to shock types, agricultural shocks are mostly coped with help from remittances and public supporting schemes in addition to reallocation of household resources in both periods. Economic setbacks are most frequently counteracted by borrowing in the first survey year (48%) while in the second year, frequency of borrowing to cope with economic shocks decreased to 22%, and resource reallocation increased to 46% (see Table 3.6). Finally, health

[26] The figures are calculated in terms of coping activities, which is different from the perspective up to now. As already pointed out, several households experienced more than one shock (see Table 3.1) and, although the majority of households took only one single activity to cope with one shock, some households applied more than one coping action.

and social shocks are most frequently counteracted by means of borrowing as well as savings with varying importance between the two periods.

Table 3.6: Distribution of coping actions in percentage of all coping actions[1] taken per type of shock

Type of shock	Survey period	No. of households who took coping action	Remittances and transfer	Resource reallocation	Borrowing	Use savings and sell assets
			(percent)			
Agriculture	1st wave	309	33	26	25	16
	2nd wave	356	24	29	16	31
Economic	1st wave	138	4	30	48	18
	2nd wave	343	8	46	22	24
Health	1st wave	248	24	4	32	40
	2nd wave	494	24	4	24	48
Social	1st wave	53	9	8	49	34
	2nd wave	182	24	8	28	40
Total[2]	1st wave	748	23	18	33	26
	2nd wave	1375	20	22	22	36

[1] Coping actions always added up to 100%
[2] For one household, multiple types of shocks and multiple coping actions per shock are possible.
Source: DFGFOR756 survey (2007) and (2008)

In the next section, the methodology will be outlined and results will be presented that should provide an answer to the remaining research questions: (iii) why do some households undertake coping actions in response to shocks while others do not; and (iv) for households who applied coping actions, to more precisely identify the relationship between household, shock and village characteristics and choice of coping activity.

3.4 Modeling coping decision and choice of coping activity

3.4.1 Methodology

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). When facing a shock, a household has two mutually excluding choices, i.e. to actively cope in order to minimize the damage or loss or not to cope, i.e. to passively bear the consequences of the shock (see section 3.3). Each of the alternative is associated with advantages (utilities). The value of the utility associated with coping (U_1) and utility associated with not coping (U_0) are supposed to be index functions of deterministic

variables (vector x') and stochastic elements (ε_0 and ε_1). β_0 and β_1 are parameter vectors measuring the signs and magnitudes of the deterministic variables

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

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

Holding all other factors constant, a household will maximize utility constrained by his ability to cope, captured by the variable vector **x**. The utility is unobservable, so that straightforward application of the economic model is impossible. However, the choice is observable and - assuming utility maximization - reveals which of the alternative provides a higher utility. Hence, the observed choice (Y) to be explained is binary, taking e.g. the value 1 for a coping action and 0 for non-coping, and we assume that a given set of explanatory variables (**x**) disposes the individual to cope or to refrain from coping with a certain probability. The probability to choose a coping action (observation $Y = 1$), reflects the probability that utility from coping (U_1) is higher than utility from not coping (U_0) and the opposite is observed for no coping action (observation $Y = 0$):

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

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

The utility from taking a coping action can be interpreted as the benefit from undertaking measures that compensate for income and asset losses caused by shocks.

To estimate the relationship between coping action and explanatory variables we applied a discrete choice decision-making model developed by Nelson and Maddala (Nelson 1974, Maddala 1999). The dependent variable in this model is an indicator of a discrete binary choice, that is unobservable (Y_i^*) and assumed to be a function of some household characteristics (X_i) and an error term ε_i for all households *i* up to *n.*

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

The result of the decision Y_i^* - in our case the chosen coping action - is observed and takes the value 1 if a coping action is taken and 0 otherwise. The model can be expanded to the multiple choice of a given number of coping activities $j = 1, 2, \ldots, J$. The probability that a coping action is chosen depends on the values of X_i and the parameters β which describe the impact of changes in X_i on the probability, and the covariance of error terms (Pindyck and Rubinfeld 1998, Greene 2003).

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

Theoretically, our research questions address two steps of decision making. In the first step, households decide between coping and non-coping action. To solve this problem the univariate binary response model can be applied (Model 1). In the second step, a coping household will decide on the type of coping action (Model 2). For this second step the expanded model that allows for the coexistence of several strategies for one type of shock is needed. For this purpose, a multivariate probit regression with a standard normal distribution is suitable because it permits non-exclusiveness and non-exhaustiveness of the dependent choices, and it relaxes the assumption of the independence of the irrelevant options assumed by a 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 different choices at a point in time where the dependent choice variables are binary (e.g. Rashid et al. 2006, Takasaki et al. 2002).

The functional form of a probit model assumes a cumulative normal distribution of the error term.

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

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

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

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

The multivariate probit model takes the form of the equation (6) 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 *(* ρ_{jk} = 1, for *j = k)* and covariances $\rho_{jk} = \rho_{kj}$ as off-diagonal elements to allow for correlation with each other (Cappellari and Jenkins 2003):

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

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

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

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

In the following, the empirical analyses present the results along the theoretical concept of a two-step decision making from above. Firstly, the general decision to cope or refrain from coping is determined by a univariate probit model (Model 1). Secondly, the selection of a specific type from the four coping actions set out in section 3.3 is analyzed by a multivariate probit regression which uses the same explaining variables as the univariate model of the first decision step (Model 2).

3.4.2 Determinants of ex-post coping actions

The models set up to reproduce the discrete binary choice relate the reported outcome of the decision to cope or not to cope to the variables derived in the descriptive section as most likely to influence the decision-making process (see section 3.3). The estimation results for the two survey periods are presented in Table 3.7[27]. Although the economic significance in terms of the magnitudes of the estimated coefficients are scale-sensitive and reflect only minor impact on the decision-making process, the statistical significance is quite good and generally reflect plausible and the right directions (signs) of the influences on the probability to cope or to refrain from coping. Among the three types of determinants (household characteristics, shock characteristics, and village characteristics), shock characteristics in terms of income and asset losses are statistically of highest importance for all types of shocks (agricultural, economic, health, and social), and the signs are positive with only one exception (income loss due to agricultural shocks for the 1st period). The results therefore confirm the expectation that the probability to cope increases with level of income and asset losses in both periods. The consistent positive significant coefficients of income and asset loss due to health shocks in both models suggest that health shocks receive utmost attention by households regardless of socio-economic conditions. Facing health shocks, the probability to take a coping action increases with increasing income

[27] The variables "subjective severity of shocks" are omitted in the models to avoid collinearity with the variables "income and asset loss from shocks".

and asset loss. By contrast, with respect to coping probability, the variables representing household characteristics show varying directions and changing significance between the periods. The same is true for location factors which show varying significance among the provinces and between the survey periods[28].

The variable household wealth as defined in section 3.3 was found to be not consistent although significant, in both survey years. Thus it seems that wealthier households are less likely to take a coping action. They perhaps did not report a coping action as their economic situation may provide adequate *ex-ante* cushion against shocks. Hence there is no need for such households, for example, to search for additional off-farm occupation or to take children out of school. The income variable shows the same direction of influence in all four models although the coefficient was not found to be significant.

Furthermore, a significant positive influence for the variable number of migrant members is found in the 2nd year. This is plausible as migrants represent an important source of complementary household income. The ratio of household members engaged in agriculture has a negative significant effect. This is a reflection of the fact that off-farm and non-farm employment is pronounced among rural Thai households. Perhaps the likelihood of coping of households is related to the type of shocks and the stronger reliance on off-farm income sources. Households who also earn from off-farm and non-farm occupation in addition to agricultural income are more capable to cope with a sudden reduction in yield or damage on agricultural land caused by flooding, drought and crop pest than households who primarily rely on agriculture as a major source of income.

Village variables show implications of infrastructure. Especially in rural areas, the market place is the platform for informal information exchange and social networking; hence being far from a market place reduces the ability to cope. This is shown in the negative significant coefficient traveling time to next market for the 2nd year. However, distance to provincial capitals is insignificant with different signs. This is possible because the sample is not identical between the two waves.

Although the coefficients between two periods partly show inconsistent direction and significance, results from the first step of coping action decision (Model 1) reveal interesting information. A significant influence of shock types and severity, household wealth and occupation, and location factor on the decision can be verified. The probability that a coping action is taken increases with income and asset loss, especially due to health shocks which show positive signs in both periods. The coping probability also increases with the number of migrant

[28] To generate more detailed information on the shock-coping behavior, the analysis has to be refined, especially with respect to the model specification, e.g. by selecting other or additional explaining variables and by setting up separate models for different shock types or provinces.

members as a potential source of remittances. Households with greater wealth and more household members engaged in agriculture, however, are less likely to apply a coping measure to deal with shocks. In addition, unfavorable village infrastructure, measured in travelling time to next market, reduces the likelihood that a coping action is taken. In the next section, the choices of coping action are further analyzed.

Table 3.7: Univariate probit results of coping action

Explanatory variables	1st wave		2nd wave	
	Coefficient	z-value	Coefficient	z-value
Household characteristics				
Annual income per capita before shock *(100 PPP$)* [a]	-0.0011	-0.33	0.0016	1.08
Annual wealth per capita before shock[b] *(100 PPP$)* [a]	-0.0007 **	-2.31	-0.0002	-0.53
Maximum years of schooling *(Years)*	-0.0089	-0.56	-0.0027	-0.25
Ratio of household members engaged in agriculture *(%)*	0.0741	0.36	-0.4413 ***	-3.15
Number of migrant member *(Persons)*	0.0297	0.67	0.0514 *	1.92
Shock characteristics				
Income loss per capita				
Agricultural shock *(100 PPP$)* [a]	0.0204	0.98	-0.0155 *	-1.73
Economic shock *(100 PPP$)* [a]	0.0389 *	1.94	0.0576 **	2.33
Health shock *(100 PPP$)* [a]	0.0639 *	1.76	0.0892 *	1.86
Social shock *(100 PPP$)* [a]	0.7845 **	2.04	0.0509	1.21
Asset loss per capita				
Agricultural shock *(100 PPP$)* [a]	0.0497	1.58	0.1707 ***	2.92
Economic shock *(100 PPP$)* [a]	0.0356	1.38	54.9989 ***	5.6
Health shock *(100 PPP$)* [a]	0.1955 **	2.47	1.0394 ***	2.81
Social shock *(100 PPP$)* [a]	0.0151	0.72	0.0285	1.56
Village characteristics				
Distance from village to provincial capital *(Kilometer)*	0.0006	0.36	-0.0001	-0.08
Travelling time to the next market *(Minutes)*	-0.0023	-0.5	-0.0075 **	-2.4
Province dummy: *1=Buriram*	0.036	0.24	-0.5029 ***	-5.02
Province dummy: *1=Nakhon Panom*	0.3201 *	2.13	-0.2224 **	-2.04
Constant	0.5076 *	2.2	0.7695	4.64
Observed probability	0.751		0.6372	
Predicted probability	0.8178		1.0000	
Number of observations	684		1280	
Wald chi2 (19)	29.29		148.05	
Prob > chi2	0.0302		0.0000	
Pseudo R2	0.0780		0.1006	
Log pseudolikelihood	-198618.84		-422698.74	

[a] Measured in PPP$ (2005) with conversion factor for THB of 0.0600 (1st wave) and 0.0582 (2nd wave)
[b] Wealth is an asset-based variable comprises of the sum of all productive and consumption assets including value of the house, own land, value of livestock and financial savings.
Source: Own calculation.

3.4.3 Choice of ex-post coping strategy

Multivariate probit models have been set up in order to detect specific relationships between a particular coping activity and the type of shock (Model 2), focusing on households that decide to take a coping action in the previous step. The models use the same set of exogenous variables and allow for multiple counteractions to cope with one shock. To ease interpretation, we concentrate in Table 3.8 solely on the direction of influence and the significance of the regression coefficients due to the scale-sensitivity and the relative low impact of the magnitudes[29]. In general, the results reveal that rural households resort to any of four major coping measures: (i) asking for public transfers and remittances, (ii) reallocating household resource, (iii) borrowing, and (iv) using saving and selling assets. In both years, the significant negative signs of rho (ρ), which measure the correlation between the errors of the four coping action equations, indicate that the decision to apply one of the four shock-coping strategies reduces the likelihood of applying the other ones. For example, a significant negative sign of rho21 indicates that the application of public transfers and remittances (coping measure (i)) significantly reduces the likelihood of applying household resource reallocation to deal with shocks (coping measure (ii)). Similar significant substitution relationships are indicated between all other pairs of coping measures (i.e. significant negative signs of rho31, rho41, rho32, rho42 and rho43). In addition, the likelihood ratio test of all coping strategies is significant in both years indicating that the multivariate probit approach is indeed more appropriate as opposed to estimating four separate standard probit models.

The results confirm the findings from the univariate model and provide additional insight to the households' coping behavior. As observed in Model 1, wealthier households are less likely to cope with shocks. In Model 2, it is further revealed that among households that decided to take a coping action, households with higher income and wealth status are more likely to use savings and sell assets. Wealthier households are also less likely to take up additional off-farm and non-farm employment or seeking to borrow in order to cope with shocks.

The education variable is significant in the 2nd wave data set for the coping action of resource reallocation, i.e. households with better education have a greater likelihood to reallocate resources. It can be assumed that such households find it easier to especially diversify labor and take up additional employment. The result is in line with the hypothesis pointed out in the previous section that education often means better access to information.

Thai households with more reliance on agriculture as a main source of income tend to avoid using savings and selling assets. This seems plausible as especially sale of assets could hamper

[29] Comprehensive numerical estimates are given in the Appendices A and B to allow for more detailed explanation.

their future productive capacity. The model however does not allow a conclusion which resources are reallocated due to lack of information on this aspect. The migration variable in the model shows that households with migrant members are likely to ask for more remittances to cope with shocks.

Among the shock variables, except for social shocks, most are significantly related to specific coping activities. Generally when comparing the two periods the direction of influence of the explanatory variables is consistent. For agricultural shocks which lead to income loss, households would turn to borrowing and resource reallocation as shown by the significant positive sign while use of savings and asset sales is significantly negative in both models. Interestingly no significant relationship was found for asking for more remittances and public support programs to cope with income loss from this shock type. This may mean for the latter option, that while the possibility exists for example through government emergency programs the practical implementation may be rather limited. Especially in Thailand households must go through a long application and approval procedure and the payment may be delayed up to several months after the event. However, results are less consistent for asset loss from agricultural shocks. Here households are more likely to apply for public transfers or ask for remittances from migrant members, relatives and friends.

For economic shocks, results are more consistent in both periods showing that borrowing is the dominant reaction as shown by the positive coefficients which are significant in both models. Similar relationship is found for resource reallocation in the 1st wave. At the same time dissolving savings and selling assets as well as asking for more remittances and public transfers are negatively related to income and asset loss from economic shocks. This shows that on the one hand economic shocks affect migrants and natal households at the same time and public programs have for such events may be largely non existent. This is different for agricultural shocks where public programs widely exist. Similar to asset losses from agriculture results are less conclusive for asset loss from economic shocks.

For health shocks, borrowing is the dominant coping action to deal with income loss especially in the 2nd period. To counteract asset loss from illness, death, accident or birth of household members, the use of savings shows a positive coefficient which is significant for the 1st wave. For social shocks, income loss caused by this type of shock encourages the reallocation of household resources as a coping measure as shown by positive significant for the 1st wave. For asset loss from social shocks, several significant coefficients are observed in either of the two periods. The higher asset loss from social shocks, the more likely households would deplete savings and borrow additional loans while asking for remittances and public transfers show significant negative relationship to asset loss.

Results of the village characteristics variables differ between the two survey years. Generally, the models show that traveling distance and access to markets influence the choice of coping. This is shown by the differences among the provinces. In addition, Thai households who live closer to the provincial capital are more likely to reallocate resources. Households living further away are more likely to use savings or sell assets while the positive coefficient of distance to the next market is positively related to borrowing, which is mostly from informal credit sources.

In summary, the results of the multivariate choice model for coping with shocks indicate that there is a significant relationship between types and severity of shocks and the choice of coping. In addition, other variables, namely household characteristics, economic and demographic conditions, location factors and shock severity are influential in making a household to choose a particular coping activity. Wealthier households, especially those in more remote areas, tend to use savings and sell asset in response to shocks.

Overall borrowing is a dominant coping measure for different kinds of shocks provided the corresponding financial infrastructure is accessible in terms of location. Asking for remittances and public transfers are strongly associated with high losses from agricultural shocks. Reallocation of household resources is another frequently used strategy to cope with economic and social shocks.

The model results differ between the two survey years. This suggests that the environmental and macroeconomic conditions on the one hand and the policy and institutional condition on the other hand may have quite some effect on the choice of coping. Hence, this lends some support to the need to develop situation and region-specific responses to assist rural households to more effectively cope with shocks.

Table 3.8: Multivariate probit results of coping activity

Explanatory variables	Coefficient							
	Remittance and transfer		Resource reallocation		Borrowing		Use savings and sell assets	
	1st wave	2nd wave	1st wave	2nd wave	1st wave	2nd wave	1st wave	2nd wave
Household characteristics								
Annual income per capita *(100 PPP$)* [a]	+	+	-	-	-	-	-	+
Annual wealth per capita before shock[b] *(100 PPP$)* [a]	-	-	-	-	-	- ***	+	+ ***
Maximum years of schooling *(Years)*	-	-	+	+ ***	-	-	+	-
Ratio of household members engaged in agriculture *(%)*	-	-	-	+	+	+	+	- **
Number of migrant member *(Persons)*	+	+ *	-	+	+	+	+	-
Shock characteristics								
Income loss per capita								
Agricultural shock *(100 PPP$)* [a]	+	-	+ ***	+ **	-	+ ***	- **	-
Economic shock *(100 PPP$)* [a]	- ***	-	+ *	+	+ *	+ *	-	- *
Health shock *(100 PPP$)* [a]	+	+	-	+	+	+ **	+	+
Social shock *(100 PPP$)* [a]	+	+	+ **	+	+	+	-	-
Asset loss per capita								
Agricultural shock *(100 PPP$)* [a]	+	+ **	-	+	+	+	-	-
Economic shock *(100 PPP$)* [a]	- **	-	+	-	+	-	+	+
Health shock *(100 PPP$)* [a]	+	-	-	+	+	-	+ **	+
Social shock *(100 PPP$)* [a]	-	- *	-	+	+	+ *	+ ***	+
Village characteristics								
Distance from village to provincial capital *(Kilometer)*	+	-	-	- *	+	-	-	+ *
Travelling time to the next market *(Minutes)*	-	-	+	+	-	+ **	+	-
Province dummy: *1=Buriram*	- **	+ **	- *	+ *	+ *	- **	-	-
Province dummy: *1=Nakhon Panom*	- ***	-	-	+ *	+ ***	-	+	-
	1st wave	2nd wave			1st wave	2nd wave		
atrho21[c]	- ***	- ***		rho21[d]	- ***	- ***		
atrho31[c]	- ***	- ***		rho31[d]	- ***	- ***		
atrho41[c]	- ***	- ***		rho41[d]	- ***	- ***		
atrho32[c]	- ***	- ***		rho32[d]	- ***	- ***		
atrho42[c]	- ***	- ***		rho42[d]	- ***	- ***		
atrho43[c]	- ***	- ***		rho43[d]	- ***	- ***		

1st wave: Number of obs = 514; Wald chi2(19) = 203.44; Prob > chi2 = 0.0000; Log pseudolikelihood = -604757.72; SML, # draws = 24
Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 1.2e+06 Prob > chi2 = 0.0000
2nd wave: Number of obs = 814; Wald chi2(19) = 186.07; Prob > chi2 = 0.0000; Log pseudolikelihood = -1033705.1; SML, # draws = 30
Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 2.1e+06 Prob > chi2 = 0.0000

[a] Measured in *PPP$ (2005)* with conversion factor for THB of 0.0600 (1st wave) and 0.0582 (2nd wave)
[b] Wealth is an asset-based variable comprises of the sum of all productive and consumption assets including value of the house, own land, value of livestock and financial savings.
[c] atrho are transformations of rho that are used in the estimation process.
[d] rho measure the correlation between the between the residuals of the four ex-post coping activity equations.
*significant at the 10% level, ** significant at the 5% level and *** significant at the 1% level

Source: Own calculation.

3.5 Summary and conclusion

Understanding the effects of shocks and existing coping strategies is essential for the design of effective poverty alleviation strategies. This chapter identifies types and effects of shocks and analyzes *ex-post* coping behavior of rural households using the data collected among some 2,200 households in two panel surveys in three provinces in Northeast Thailand (specific research objective (I)). As a starting point, broad shock-coping action-structure in the study region is described, including summarizing household characteristics and location factors. The aggregation criteria applied to categorize the variables, especially shocks and coping actions, are based on plausible considerations and mostly taken from the literature.

Descriptive results of the two panel surveys show that a large number of rural households experienced shocks. As compared to the 2007 survey year, the number of households affected by shocks doubled with more shock events per household in the second survey period. The most frequent type of shocks is weather-related events, such as drought and flooding, which are particularly significant for agriculture. The next most frequent type of shocks are health shocks especially illness but also death of household members, followed by economic shocks such as price fluctuations, job loss and business collapse, while social shocks represent the least-frequent shock category. It was also found that reported shock types correlate with the level of well-being of the households as measured in income and asset. While poorer households are more susceptible to health shocks, wealthier households are more prone to economic and social shocks. It is striking, that many households who experienced shocks did not take any coping action, and most remarkably, coping is more likely to take place for health related events as compared to other shock types, especially shocks related to agricultural or social relationships. Although a straightforward explanation is difficult, these shocks in many cases may be below the household's individual action threshold. One could argue that Thai households have less "need to cope" due to higher income and wealth which lowers their action threshold.

The *ex-post* shock-coping behavior of households can be decomposed as a two-step decision-making process. In the first step, households decide between coping and non-coping action. Having decided to take a coping action in the first step, the household will decide on the type of coping action in the second step. To capture the first step of the coping decision, a univariate probit model was developed to find out why some households cope while others do not. Results show that the probability to cope increases with income and asset loss, especially income and asset loss due to health shocks which show positive significant influence in both periods. In addition, households with more migrant members are also more likely to adopt a coping action. On the contrary, households' wealth status and engagement in agriculture as well as further distance to market are negatively correlated to the coping action probability. Social risk

management should therefore aim at assisting targeted poor farm households who live in remote area in undertaking a coping measure to overcome shocks.

For the second step, the analysis is refined by a multivariate probit regression approach in order to assign specific coping measures to different shock categories for households that decided to take a coping action in the previous step. Modeling results revealed significant relationships between shock types and their severity and the choice of coping measures. Household characteristics, economic and demographic circumstances, location conditions are additional factors. Borrowing was identified as the major coping measure for all types of shocks especially among lower-income households while using savings and selling assets is preferred by households with higher income. Asking for remittances and public transfers is most likely applied to cope with agricultural shocks. Additionally, self-insurance measures such as the reallocation of household resources, plays a prominent role to deal with agricultural shocks, especially among households with higher education level. The current situation reveals that households are usually left alone to deal with shocks using their own available resources and the public supports are rarely used. In particular, borrowing as well as savings and asset accumulation seem to be of great importance as coping measures for all shock types, facilitating households to build savings and improve credit markets would therefore strengthen private insurance measures.

In summary it must be acknowledged that while the multivariate probit models showed some constant pattern of relationships between periods, results also carry a fair degree of variation between the two survey years. This is perhaps not surprising considering that environmental and macroeconomic conditions vary over time. In the absence of an analysis assessing the effectiveness and efficiency of the households' own coping measures one must be careful to derive policy recommendations. Nevertheless, the analysis of the two year data from the three provinces in Thailand indicate that in the design of social protection policies for remote rural areas, situation- and location-specific considerations are needed. These must take into account the extent of infrastructure in rural areas, the demographic pattern of village populations as well as the livelihood strategies and the resource base of the rural households. The results presented here are only a first step toward a better understanding of the role of shocks, coping choices and the vulnerability of rural households in Thailand. Further analyses using models which can address more specific aspects of the shock-coping structure and using a longer panel will provide further insights for deriving more concrete policy recommendations.

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This chapter presents an extended analysis as compared to the paper version.

Chapter 4

Weather Risk Perception and *ex-ante* Mitigation Strategies of Rural Households

4.1 Introduction

Thailand and Vietnam are two emerging market economies where vulnerability to poverty remains a fundamental challenge in spite of successful advances in extreme poverty reduction. (World Bank 2003a, ADB 2008, UNDP 2008, World Bank 2008b). Between 1992 and 2006, poverty headcount ratio, based on the international US$1.25 poverty line, has substantially declined from 22% to 1% in Thailand and from 64% to 6% in Vietnam. However, vulnerability to poverty continues its spell as about 12% of Thailand's and 49% of Vietnam's population still struggle to survive with less than US$2 per day in 2005. Based on national estimates, a poverty incidence of 8.5% in Thailand[30] (2005) and 16% in Vietnam (2006)[31] are prevalent. One of the important factors responsible for vulnerability to poverty of households is the inadequate ability to cope with shocks *ex-post* as well as to manage risk *ex-ante*, especially for those living in rural area with fewer social, technical and financial resources (World Bank 2010, UNFCCC 2007).

As demonstrated in chapter 3, the majority of rural households are most frequently and severely affected by weather-related agricultural shocks such as drought and flooding, which are particularly significant for agriculture. Persistence of adverse weather shocks can be attributed to climate change. According to the Intergovernmental Panel on Climate Change (IPCC), climate change refers to "a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer" (IPCC 2007). Causes of climate change can be attributed to human activities altering the atmospheric composition and climate variability due to natural influences (UNFCCC 2007). Major concern regarding long-term climatic change is

[30] Measured at the national poverty line of THB 1,443, equivalent to PPP$ 83.98 (NESDB).
[31] Measured at the national poverty line of VND 213,250, equivalent to PPP$ 36.24 (General Statistics Office and the World Bank in Vietnam).

its manifestation through changing weather conditions such as higher temperatures, increasingly erratic rainfall, longer period of drought, leading to an increased frequency, variability and severity of weather distresses and increasing risk of adverse weather conditions (IPCC 2007, ADB 2009a). In addition environmental degradation caused by climate change continues (Millennium Ecosystem Assessment 2005), which damages natural resources that are crucial for the livelihoods of rural poor and vulnerable households (World Bank 2005b). Change in weather conditions pose direct threat to rural farm households. Rising temperature, irregular rainfall, prolonged drought periods, for example, are critical for farm households who rely on agriculture as a major source of income and employment (Sivakumar and Motha 2007). Although some dry areas may benefit from increasing rainfalls in some periods, the widening variation of climatic pattern is becoming an important concern for farm households that need to adjust farm planning and cultivation behavior accordingly (Jitsuchon 2010). An impact study of weather change on rice production in Thailand conducted by Felkner et al. (2009) shows that although most farm households manage to cope with milder weather change, they are less equipped to handle the adverse effects of the more extreme weather change. In particular, poor farm households are least capable of protecting themselves against weather risk and most vulnerable to poverty in case negative weather shocks occur. As found in a study about climate change Asian countries are faced with high costs of adapting to the adverse effects associated with climate change (ADB 2009a). Hence, the issue of weather adversities induced by climate change is of great importance and relevance for rural agricultural households not only at the present but also in the future.

Up to date, existing studies related to weather risk and agriculture are mainly objective based on historical statistics such as rainfall, temperature and other environmental variables for surveillance and forecasting models (e.g. Musser et al. 1984, Boisvert 1990, Jitsuchon 2010). For example, climate models focusing on weather variability in Vietnam have been based on historical data on the frequency and strengths of weather events such as rainfall, storms and typhoons (Ngyuen Tuong 2010). In Thailand, modeling of weather change impacts on crop yield make use of farm input and operational data together with rainfall and chemical composition of water resources (Felkner et al. 2009). While objective data allow a fair degree of analytical precision for climate change modeling, they entail several disadvantages. First, historical data are backward-looking allowing for fewer implication basis necessary for proactive policy recommendations that should offer forward-looking perspective. Second, models based on objective information generally do not take into account subjective individual perceptions and preferences of the decision makers (Anderson et al. 1977). With such models it is difficult to influence the behavior of decision makers because it is the subjective perception of risk that influences their decision-making. Considering the drawbacks of objective-based modeling, it is

therefore important to enhance the model efficiency with subjective perceptions of the decision makers.

In the context of vulnerability to poverty, it is essential to understand how rural households subjectively perceive weather risk (i.e. the likelihood and severity of weather variation) and how the risk perception is translated into households' *ex-ante* risk management strategies. As the long-term changing climatic conditions is expected to cause significant increase of weather distress, the analysis in this chapter aims to capture an aspect of climate change by focusing on recent weather shock experiences, weather risk perception formation and induced *ex-ante* weather risk mitigating behavior of rural households (specific research objective (II)). Although risk perception is a well-established concept, the implication of weather risks on the livelihoods and vulnerability to poverty of rural farm households in developing countries has rarely been addressed. To advance the research in this area and to clarify the relationship between shock experience, risk perception and risk prevention, this chapter focuses on analyzing both the determinants of weather risk perception and its influence on households' behavior regarding *ex-ante* mitigation strategies of rural households in Northeast Thailand and Central Vietnam by investigating the following research questions:

(i) What is the current status of weather shock experience, risk perception and *ex-ante* risk management of vulnerable rural households in the study areas?

(ii) What determinants shape weather risk perception?

(iii) How does weather risk perception affect the households' decision to apply any *ex-ante* risk management actions?

(iv) What effect does weather risk perception has on the use of specific *ex-ante* risk management strategies?

The chapter is organized as followed. Section 4.2 presents results of a descriptive analysis of households' experience with weather shocks and their weather risk perception, as well as major *ex-ante* risk management measures (research question (i)). Section 4.3 describes the methodology used for empirically testing the relationship between shock experience and risk perception, as well as between weather risk perception and the adoption of *ex-ante* risk management strategies. Section 4.4 addresses the remaining research questions (ii), (iii) and (iv) by presenting the empirical model results, and the last section 4.5 provides summary and conclusions.

4.2 Descriptive analysis of shock experiences, risk perception and *ex-ante* mitigation strategies of vulnerable rural households

Thailand and Vietnam are two of the countries in Southeast Asian region being highly vulnerable to expected climate change. In both countries, great exposure to climate hazards and high human and ecological sensitivity contribute to substantial climatic vulnerability despite relative high adaptive capacity (Yusuf and Francisco 2009). According to their recent vulnerability mapping study, droughts, floods and rising sea level are dominant hazards identified in Thailand especially for areas surrounding Bangkok and Southern region. However, the North and Northeast regions are in fact more vulnerable since the majority of the country's poor population resides in these areas. With substantial rise in temperature and change in rainfall pattern, most of rain-fed rice farmers in the Northeastern provinces suffered one of the most severe droughts in decades in 2007-2008 (Jitsuchon 2010). With its country-long coastal area adjacent to Gulf of Tonkin, South China Sea and Gulf of Thailand, poor rural Vietnamese households living in the Northwestern, Eastern coastal areas and Mekong region are under serious threats of droughts, cyclones and rising sea level.

Based on the data collected from two base panel surveys among almost 4,400 households in six provinces in Thailand and Vietnam (see chapter 2), the current status of weather shock experience, risk perception and *ex-ante* risk management of rural households in the study area (research question (i)) is presented in this section. As shown in Table 4.1a, rural households in both countries were affected by different types of unexpected adversities, including weather, biological, socio-demographic as well as economic shocks. As compared to the analysis in chapter 3, both weather shocks and biological shocks can be aggregated to agricultural shocks. However, to emphasize the relevance of weather shocks in this chapter, weather shocks are identified by flooding, unusually heavy rainfall, storm, drought and unusually cold weather, while biological shocks signify crop pests and livestock diseases. The descriptive analysis is refined to differentiate sub-categories of weather shocks in order to better reflect the frequency and severity of each weather shock event. During the last 7 years, shock experiences between January 2002 until April 2007 (1st base panel survey) and between May 2007 until April 2008 (2nd base panel survey) reveal that adverse weather shocks are the most prevalent type of calamity experienced by households. This type of shock affected more than half and about three quarters of the rural population in Thailand and Vietnam, respectively. On average, each household in both countries was affected by about two weather shocks but Vietnamese households assessed the severity of shock incidents to having been higher than Thai households. However, standard deviations of reported shock frequency and severity show that some households suffered a higher number or severity of shocks while others were not affected at all or only by events of low severity in both countries.

A similar variation in shock frequency and severity can be observed for other shock types. Socio-demographic shocks were reported with the second-highest frequency in both countries (approximately 40% in Thailand and 60% in Vietnam) with illnesses of household members ranked high while other events, such as death of household members, was only experienced by a small share of households. Biological shocks (e.g. crop pests and livestock diseases) affected about 40% of rural households in Vietnam but only about 13% in Thailand. Last but not least, economic adversities, especially unexpected fluctuations in input and output prices, made up for a substantial proportion in Thailand (about 23%) but generally played a minor role in Vietnam with only about 10% of households affected. This difference may be attributed to higher market integration in Thailand as compared to Vietnam on the international, national and local level on the one hand, and to different political settings and market infrastructure on the other hand.

For all type of events, the perception of future risks is by far higher than shock experience in both countries (Table 4.1a). Based on their shock experience in the 7-years reference period (i.e. from 2002 to 2008), households appear to be rather pessimistic about the incidence of risk events expecting to occur in the next 5 years (i.e. from 2008 to 2013). Descriptive results indicate that not only households that were affected by shocks fear that the same shocks will occur again but also a large share of non-affected households are anticipating all types of events to happen in the future. In Vietnam, risk of weather events (especially drought, flooding and storm) remain the most prevalent type of calamity expected by the highest share of households followed by socio-demographic risks (i.e. mainly illness of household members) while the opposite order is observed for the majority of Thai households. Almost 70% of Thai households fear that economic risks such as rising in production input prices and falling in output prices will affect them comparing to a smaller but still considerable share of 41% of Vietnamese households. On the other hand, 75% of Vietnamese households anticipate biological risks especially crop pest and livestock diseases comparing to 44% in Thailand.

Compared to the past shock incidences, households in both countries anticipated all events to occur in the future 2 to 5 times more frequently and the highest frequency is expected for weather risk and socio-demographic risk. In terms of expected severity households in both countries expected the adverse effects of risks to be higher on income than on assets, particularly severity on income from climatic and economic risk. Overall, a relatively greater pessimism is observed among Thai households. While Vietnamese households subjectively estimate future risk event to have similar impact on income and lower impact on asset than the overall shock severity, Thai households expect future risk events to have more severe impact on both income and assets than the impact caused by past shocks.

To give a clear picture of shock and risk situation faced by poor and vulnerable households, Table 4.1b and 4.1c further highlight the shock situation and risk perception of households in different income levels indicated by the poverty status of below and above regional poverty line[32]. The comparison reveals that the poor has about 20% greater exposure to weather shocks more than the non-poor in both countries. On the other hand, biological and socio-demographic shocks more or less equally affected both income groups in each country. Regarding economic shocks, although similar shock frequency and severity estimation are reported by both income groups in each country, the data reveals a more severe vulnerable situation among the poor households facing by this type of shock. In Thailand, the share of the non-poor affected by this type of shock is about 9% higher than share of the poor while this figure amounts to 100% in Vietnam.

In terms of risk perception, poor households are more pessimistic about all future risk events than the non-poor counterparts. Fearing weather risks in particular, the results show consistent pattern in both countries that larger share of poor households expects this type of risk to occur in a higher frequency and a greater severity in income and asset than better-off households. For socio-demographic risks, similar pattern is observed in both countries with an exception that the shares of anticipating households are identical between the two groups. The main difference between the two countries is how the poor anticipate biological and economic risks in comparison to the non-poor. While only households below poverty line continue to be more pessimistic toward biological risks in Vietnam, this type of risk is equally feared regardless of income level in Thailand with an exception in a larger asset severity estimated by the poor group. Economic risks further show a disparity of risk perception between the two income groups as more of non-poor Vietnamese fear the economic adversities, a larger share of poor Thai households expects to be affected by the economic downturns. The expected frequency of economic risks, however, is higher among the poor in both countries but the expected impact on income and asset is more pronounced among poor Thai households.

[32] Regional poverty line (per capita/month) is PPP$ 76.59 in Thailand (NESDB) and PPP$ 36.24 in Vietnam (General Statistics Office and the World Bank in Vietnam).

Table 4.1: Shock events experienced between 2002 and 2008 and risk types perceived in 2008

a) Overall

Thailand (N = 2127[1])							
	Households (%)		Frequency per household[2]		Subjective severity[3]		
Type of events	*Shock*	*Risk*	*Shock*	*Risk*	*Shock*	*Risk (income)*	*Risk (asset)*
Weather	**53.9**	**73.2**	**1.9** ***(1.4)***	**4.2** ***(4.2)***	**0.9** ***(0.5)***	**2.1** ***(0.9)***	**1.2** ***(1.2)***
Flooding	34.8	22.6	1.6 *(1.3)*	3.2 *(1.7)*	0.7 *(0.5)*	2.3 *(0.9)*	1.4 *(1.3)*
Drought	41.9	57.3	1.6 *(1.1)*	3.2 *(1.6)*	0.8 *(0.5)*	2.3 *(0.8)*	1.3 *(1.3)*
Heavy rainfall	2.5	18.7	1.4 *(1.3)*	2.8 *(1.6)*	0.5 *(0.4)*	1.7 *(1.2)*	1.2 *(1.3)*
Erosion	0.3	1.7	1.0 *(0.0)*	2.6 *(1.8)*	0.2 *(0.1)*	1.9 *(1.0)*	2.0 *(1.1)*
storm	2.1	26.7	1.0 *(0.2)*	2.9 *(1.8)*	0.4 *(0.3)*	1.8 *(1.2)*	1.6 *(1.3)*
Snow/ice rain	0.5	11.5	1.1 *(0.3)*	2.7 *(1.7)*	0.5 *(0.4)*	1.1 *(1.2)*	1.0 *(1.2)*
Biological	**15.3**	**44.1**	**1.3** ***(0.6)***	**2.5** ***(3.8)***	**0.6** ***(0.4)***	**1.8** ***(0.9)***	**1.2** ***(1.1)***
Socio-demographic	**51.2**	**89.0**	**1.8** ***(1.3)***	**4.7** ***(3.9)***	**0.9** ***(0.7)***	**1.8** ***(0.9)***	**1.0** ***(1.1)***
Economic	**27.5**	**69.5**	**1.4** ***(0.9)***	**4.5** ***(4.5)***	**0.6** ***(0.5)***	**2.5** ***(0.7)***	**1.2** ***(1.2)***
Vietnam (N = 2146[1])							
	Households (%)		Frequency per household[2]		Subjective severity[3]		
Type of events	*Shock*	*Risk*	*Shock*	*Risk*	*Shock*	*Risk (income)*	*Risk (asset)*
Weather	**75.2**	**90.0**	**1.7** ***(0.8)***	**8.4** ***(6.4)***	**2.7** ***(0.5)***	**2.3** ***(0.8)***	**0.9** ***(1.0)***
Flooding	34.3	52.7	1.2 *(0.5)*	3.9 *(1.6)*	2.7 *(0.5)*	2.5 *(0.8)*	0.8 *(1.1)*
Drought	27.3	53.7	1.2 *(0.5)*	3.1 *(1.7)*	2.7 *(0.5)*	2.3 *(0.8)*	0.2 *(0.5)*
Heavy rainfall	14.9	35.4	1.0 *(0.2)*	3.3 *(1.8)*	2.6 *(0.6)*	2.2 *(0.9)*	1.1 *(1.1)*
Erosion	1.0	5.0	1.0 *(0.2)*	2.9 *(1.8)*	2.9 *(0.4)*	2.2 *(0.9)*	1.1 *(1.1)*
storm	15.9	54.9	1.0 *(0.2)*	4.2 *(1.7)*	2.6 *(0.6)*	2.1 *(0.9)*	1.8 *(1.1)*
Snow/ice rain	16.5	7.5	1.0 *(0.0)*	3.4 *(1.5)*	2.6 *(0.5)*	2.0 *(1.0)*	0.9 *(0.9)*
Biological	**40.2**	**75.2**	**1.3** ***(0.6)***	**5.7** ***(3.2)***	**2.6** ***(0.5)***	**2.3** ***(0.8)***	**0.3** ***(0.7)***
Socio-demographic	**60.1**	**85.5**	**1.6** ***(0.8)***	**5.5** ***(3.4)***	**2.6** ***(0.5)***	**1.8** ***(0.9)***	**0.7** ***(0.9)***
Economic	**9.2**	**41.3**	**1.1** ***(0.4)***	**5.0** ***(3.1)***	**2.7** ***(0.5)***	**2.2** ***(0.8)***	**0.4** ***(0.9)***

Note: [1] Complete sample of households with at least 1 nucleus member which were interviewed in both survey waves.
[2] Number of shocks and shock severity were computed exclusively for households affected by the respective shock type. Standard deviations are presented in brackets. Expected number of risk and risk severity were computed exclusively for households perceiving the respective risk type.
[3] Shock and risk severity measured as ordinal scale from 0 (=no impact) to 3 (=high severity). Standard deviations are presented in brackets.
Source: DFGFOR756 survey (2007) and (2008)

Table 4.1: Shock events experienced between 2002 and 2008 and risk types perceived in 2008

b) Below poverty line[1]

Thailand (N = 824[2])							
	Households (%)		Frequency per household[3]		Subjective severity[4]		
Type of events	*Shock*	*Risk*	*Shock*	*Risk*	*Shock*	*Risk (income)*	*Risk (asset)*
Weather	**43.9**	**75.5**	**1.9** ***(1.4)***	**4.5** ***(4.4)***	**0.9** ***(0.5)***	**2.2** ***(0.9)***	**2.2** ***(0.9)***
Flooding	14.7	24.5	1.6 *(1.3)*	3.3 *(1.7)*	0.7 *(0.5)*	2.4 *(0.8)*	2.4 *(0.8)*
Drought	30.8	59.5	1.6 *(1.1)*	3.3 *(1.5)*	0.8 *(0.5)*	2.4 *(0.8)*	2.4 *(0.8)*
Heavy rainfall	2.3	18.1	1.3 *(0.9)*	2.8 *(1.6)*	0.5 *(0.4)*	1.8 *(1.1)*	1.8 *(1.1)*
Erosion	0.4	1.9	1.0 *(0.0)*	3.0 *(1.8)*	0.3 *(0.2)*	1.9 *(1.0)*	1.9 *(1.0)*
storm	2.4	29.0	1.0 *(0.0)*	3.0 *(1.8)*	0.4 *(0.3)*	1.9 *(1.1)*	1.9 *(1.1)*
Snow/ice rain	0.2	12.1	1.0 *(0.0)*	2.9 *(1.8)*	0.3 *(0.1)*	1.2 *(1.3)*	1.2 *(1.3)*
Biological	**11.5**	**43.9**	**1.3** ***(0.6)***	**2.6** ***(3.9)***	**0.6** ***(0.4)***	**1.9** ***(0.9)***	**1.9** ***(0.9)***
Socio-demographic	**39.8**	**89.3**	**1.8** ***(1.4)***	**4.9** ***(3.9)***	**0.9** ***(0.6)***	**1.9** ***(0.9)***	**1.9** ***(0.9)***
Economic	**20.8**	**72.7**	**1.4** ***(0.8)***	**4.8** ***(4.7)***	**0.6** ***(0.4)***	**2.5** ***(0.7)***	**2.5** ***(0.7)***
Vietnam (N = 818[2])							
	Households (%)		Frequency per household[3]		Subjective severity[4]		
Type of events	*Shock*	*Risk*	*Shock*	*Risk*	*Shock*	*Risk (income)*	*Risk (asset)*
Weather	**82.3**	**90.0**	**1.8** ***(0.8)***	**9.8** ***(6.9)***	**2.7** ***(0.4)***	**2.4** ***(0.7)***	**1.0** ***(1.0)***
Flooding	44.6	58.2	1.3 *(0.5)*	4.2 *(1.5)*	2.8 *(0.4)*	2.6 *(0.7)*	0.9 *(1.1)*
Drought	24.2	54.2	1.2 *(0.4)*	3.5 *(1.7)*	2.8 *(0.5)*	2.4 *(0.8)*	0.2 *(0.6)*
Heavy rainfall	16.4	36.2	1.0 *(0.2)*	3.6 *(1.8)*	2.7 *(0.5)*	2.3 *(0.8)*	1.2 *(1.2)*
Erosion	2.0	5.6	1.1 *(0.3)*	3.6 *(1.8)*	2.9 *(0.3)*	2.1 *(0.9)*	1.3 *(1.1)*
storm	20.1	60.6	1.1 *(0.3)*	4.3 *(1.7)*	2.6 *(0.6)*	2.2 *(0.9)*	1.8 *(1.0)*
Snow/ice rain	21.0	10.4	1.0 *(0.0)*	3.6 *(1.5)*	2.6 *(0.6)*	2.0 *(0.9)*	1.0 *(1.0)*
Biological	**42.4**	**75.9**	**1.4** ***(0.7)***	**6.1** ***(3.2)***	**2.7** ***(0.5)***	**2.4** ***(0.7)***	**0.3** ***(0.8)***
Socio-demographic	**60.2**	**83.5**	**1.6** ***(0.8)***	**5.9** ***(3.6)***	**2.7** ***(0.5)***	**1.9** ***(0.9)***	**0.8** ***(0.9)***
Economic	**5.4**	**33.1**	**1.1** ***(0.4)***	**5.4** ***(3.3)***	**2.7** ***(0.5)***	**2.2** ***(0.8)***	**0.4** ***(0.9)***

Note: [1] Regional poverty line (PPP$/person/month): 76.59 (TH) and 36.24 (VN)

[2] Complete sample of households with at least 1 nucleus member which were interviewed in both survey waves.

[3] Number of shocks and shock severity were computed exclusively for households affected by the respective shock type. Standard deviations are presented in brackets. Expected number of risk and risk severity were computed exclusively for households perceiving the respective risk type.

[4] Shock and risk severity measured as ordinal scale from 0 (=no impact) to 3 (=high severity). Standard deviations are presented in brackets.

Source: DFGFOR756 survey (2007) and (2008)

Table 4.1: Shock events experienced between 2002 and 2008 and risk types perceived in 2008

c) Above poverty line[1]

Thailand (N = 1303[2])							
	Households (%)		Frequency per household[3]		Subjective severity[4]		
Type of events	*Shock*	*Risk*	*Shock*	*Risk*	*Shock*	*Risk (income)*	*Risk (asset)*
Weather	**36.6**	**71.8**	**1.8** ***(1.4)***	**4.0** ***(4.1)***	**0.9** ***(0.5)***	**2.0** ***(1.0)***	**1.2** ***(1.2)***
Flooding	11.9	21.3	1.6 *(1.2)*	3.2 *(1.7)*	0.7 *(0.5)*	2.2 *(1.0)*	1.3 *(1.3)*
Drought	26.1	56.0	1.5 *(1.1)*	3.1 *(1.6)*	0.8 *(0.5)*	2.3 *(0.9)*	1.2 *(1.3)*
Heavy rainfall	2.4	19.1	1.5 *(1.4)*	2.8 *(1.6)*	0.5 *(0.4)*	1.6 *(1.2)*	1.1 *(1.2)*
Erosion	0.3	1.5	1.0 *(0.0)*	2.2 *(1.8)*	0.2 *(0.0)*	2.0 *(1.1)*	2.1 *(1.1)*
storm	1.6	25.3	1.0 *(0.2)*	2.8 *(1.8)*	0.4 *(0.3)*	1.7 *(1.2)*	1.6 *(1.3)*
Snow/ice rain	0.6	11.1	1.1 *(0.4)*	2.6 *(1.7)*	0.6 *(0.4)*	1.0 *(1.2)*	0.9 *(1.1)*
Biological	**12.8**	**44.2**	**1.2** ***(0.6)***	**2.5** ***(3.8)***	**0.6** ***(0.4)***	**1.8** ***(0.9)***	**1.1** ***(1.1)***
Socio-demographic	**38.8**	**88.9**	**1.8** ***(1.3)***	**4.5** ***(3.8)***	**1.0** ***(0.7)***	**1.8** ***(0.9)***	**1.0** ***(1.0)***
Economic	**22.7**	**67.5**	**1.4** ***(0.9)***	**4.3** ***(4.5)***	**0.6** ***(0.5)***	**2.4** ***(0.8)***	**1.1** ***(1.2)***
Vietnam (N = 1375[2])							
	Households (%)		Frequency per household[3]		Subjective severity[4]		
Type of events	*Shock*	*Risk*	*Shock*	*Risk*	*Shock*	*Risk (income)*	*Risk (asset)*
Weather	**68.4**	**87.0**	**1.6 (0.8)**	**7.6** ***(5.9)***	**2.6** ***(0.5)***	**2.2** ***(0.8)***	**0.9** ***(0.9)***
Flooding	27.1	47.6	1.2 (0.5)	3.7 *(1.7)*	2.7 *(0.5)*	2.4 *(0.9)*	0.7 *(1.1)*
Drought	28.2	51.6	1.2 (0.5)	2.9 *(1.6)*	2.7 *(0.5)*	2.3 *(0.8)*	0.1 *(0.5)*
Heavy rainfall	13.5	33.8	1.0 (0.2)	3.0 *(1.8)*	2.6 *(0.6)*	2.2 *(1.0)*	1.0 *(1.1)*
Erosion	0.4	4.5	1.0 (0.0)	2.4 *(1.7)*	2.7 *(0.5)*	2.2 *(0.9)*	1.0 *(1.1)*
storm	12.9	49.7	1.0 (0.1)	4.1 *(1.7)*	2.5 *(0.6)*	2.1 *(0.9)*	1.7 *(1.1)*
Snow/ice rain	13.3	5.5	1.0 (0.0)	3.2 *(1.5)*	2.6 *(0.5)*	2.1 *(1.0)*	0.7 *(0.9)*
Biological	**37.5**	**72.2**	**1.3 (0.5)**	**5.5** ***(3.1)***	**2.6** ***(0.5)***	**2.2** ***(0.8)***	**0.2** ***(0.6)***
Socio-demographic	**58.0**	**83.7**	**1.6 (0.8)**	**5.3** ***(3.3)***	**2.6** ***(0.6)***	**1.7** ***(0.9)***	**0.6** ***(0.9)***
Economic	**11.1**	**44.9**	**1.1 (0.3)**	**4.9** ***(3.0)***	**2.7** ***(0.5)***	**2.2** ***(0.8)***	**0.4** ***(0.9)***

Note: [1] Regional poverty line (PPP$/person/month): 76.59 (TH) and 36.24 (VN)
[2] Complete sample of households with at least 1 nucleus member which were interviewed in both survey waves.
[3] Number of shocks and shock severity were computed exclusively for households affected by the respective shock type. Standard deviations are presented in brackets. Expected number of risk and risk severity were computed exclusively for households perceiving the respective risk type.
[4] Shock and risk severity measured as ordinal scale from 0 (=no impact) to 3 (=high severity). Standard deviations are presented in brackets.
Source: DFGFOR756 survey (2007) and (2008)

Although the majority of households anticipate weather risks to occur in the next 5 years, only about 20% of Thai households and 30% of Vietnamese households applied any *ex-ante* risk management strategies in order to prevent the adverse effects of future weather shocks (Table 4.2). In both countries, the most common *ex-ante* risk mitigation actions are focusing on the physical prevention of damage. These actions can be classified in two categories. First, households generally undertake individual measures, namely investment activities, income portfolio adjustment and savings accumulation. About 4% in Thailand and 12% of households in Vietnam invested in the security of their own homestead as well as in physical and human capital. While the first measure focuses on the physical prevention of adverse weather calamity

effects including, for example, building elevated wooden platforms as a place of retreat when flood waters enter the house or structural reinforcements of buildings to make them more resistant to storm damage, the latter extends the ability of households to equip their members with skills to deal with adverse effects of weather risk. Furthermore, households can adjust income portfolio by changing agricultural production (e.g. organic agriculture and diversification of crop, plot and livestock) and varying income sources between on-farm agriculture and off-farm employment. Savings accumulation is another individual *ex-ante* mitigation strategy which includes, for example, building up of buffer stock (e.g. storage of food and seeds), and savings accounts in financial institutions. Other *ex-ante* risk management strategies such as migration were only applied by very few households probably because of the location-restriction imposed by reliance on agriculture as major occupation, a finding similar to a study conducted by Ologunorisa and Adeyemo (2005). Note that not every above mentioned *ex-ante* mitigation measures are directly related to long-term climate change but as a short-term response to adverse weather risks.

Second, households may join together to implement a collective action to avert the threat of weather hazards. About 8% in Thailand and 13% of households in Vietnam engaged in collective action by improving the infrastructure. Such infrastructure includes, for instance, river dikes which help to prevent flood water from overflowing agricultural land, and irrigation canals that maintain water provision to cropping system during times of drought. Furthermore, some households jointly managed common property resources, such as forests and lakes to ensure a sustainable extraction of natural resources. Collective action as a mean to adapt to weather change has become increasingly important in Vietnam where local-level hazard planning and defense systems which had been previously provided by the state were decentralized in the mid-1990s (Adger 2003). It is argued that, particularly for marginalized groups, collective action will be a crucial mean to maintain security in an increasingly risky natural environment.

For every strategy, households in the lower income group undertake *ex-ante* risk mitigation actions more than higher-income households in Vietnam whereas the opposite relationship is found in Thailand (Table 4.2). In terms of monetary equivalent estimation, Thai households spend on average almost six times more on *ex-ante* mitigating risk than Vietnamese households. In Thailand, the largest expense is by far incurred on investment activity especially in the security of homestead. Moreover, the data shows that poor households spend almost three times more on the investments than households above the poverty line. This extensive spending is plausible since house and homestead are regarded as the most valuable asset and most essential for livelihoods of the poor. With low income, poor households place the priority on ensuring the security of own house and homestead before building up savings or join collective action with other households. However, when a collective action is made, it is again poor households who

spend more cost to help strengthening common infrastructure and resources than the better-off group. In Vietnam more or less the same amount is spent on all four mitigation actions and the expense amount is similar for collective action and income portfolio adjustment regardless of income level. However, non-poor households spend more than twice and one-third as much as the poor households on savings accumulation and investment activities, respectively.

At the onset, a cross-country difference in *ex-ante* risk mitigation behavior can be identified. In Vietnam, collective action and investment activities are apparently the most common strategies applied by households. However, relatively few Vietnamese households preferred income diversification and savings accumulation as *ex-ante* risk coping actions. These measures are therefore excluded from further analysis for Vietnam. In Thailand, on the contrary, apart from collective action which is applied by the majority, similar shares of households in Thailand decided to undertake investments, adjust income portfolio and build up savings. Thus, all four *ex-ante* risk mitigation strategies are considered in the following analysis regarding specific choice of mitigation strategies.

Table 4.2: *Ex-ante* risk mitigation strategies for weather risks perceived in 2008

Type of coping strategy	Thailand (n= 1557[1])						Vietnam (n = 1932[1])					
	Below poverty line[2] (n=628)			Above poverty line[2] (n=929)			Below poverty line[2] (n=1551)			Above poverty line[2] (n=381)		
	HH	**Cost of ex-ante mitigation (PPP$)**		**HH**	**Cost of ex-ante mitigation (PPP$)**		**HH**	**Cost of ex-ante mitigation (PPP$)**		**HH**	**Cost of ex-ante mitigation (PPP$)**	
	%	Mean	*Std.Dev.*	*%*	Mean	*Std.Dev.*	*%*	Mean	*Std.Dev.*	*%*	Mean	*Std.Dev.*
Any coping strategy	**6.9**	**437.4**	***2274.2***	**11.5**	**333.0**	***742.4***	**34.9**	**62.5**	***166.2***	**24.7**	**65.7**	***172.0***
Collective action	**3.1**	**425.1**	***1715.8***	**5.1**	**186.8**	***276.1***	**14.4**	**94.0**	***352.8***	**10.8**	**99.6**	***280.6***
Collective action for infrastructure	3.1	425.1	*1715.8*	5.0	188.5	*277.5*	13.2	100.2	*369.2*	10.0	103.5	*291.4*
Common property resource management	-	-	-	0.1	58.2	-	3.2	36.5	*31.7*	1.6	48.6	*24.6*
Investment activity	**1.4**	**1084.4**	***2472.7***	**2.4**	**430.8**	***422.9***	**12.3**	**128.4**	***675.9***	**10.5**	**168.6**	***352.1***
Investment in security of homestead	0.2	3988.6	*6627.5*	0.1	164.4	*150.2*	11.9	81.4	*182.5*	10.5	168.6	*352.1*
Investment in physical and human capital	1.2	625.8	*790.7*	2.3	445.6	*429.1*	0.3	2310.3	*4500.6*	-	-	-
Investment in travel safety	-	-	-	-	-	-	0.1	90.6	-	-	-	-
Income portfolio adjustment	**1.2**	**74.4**	***147.4***	**1.5**	**555.5**	***1242.9***	**4.4**	**182.8**	***329.5***	**1.3**	**190.3**	***20.3***
Crop, plot, livestock diversifiaction	0.3	218.3	*278.6*	0.5	989.4	*1986.1*	2.0	147.6	*188.2*	0.5	203.9	*32.0*
Income source diversification	0.8	35.8	*49.2*	1.0	361.0	*628.9*	1.7	114.0	*109.6*	0.8	181.2	*0.0*
Switch to more secure income sources	0.1	1.0	-	0.1	1.0	-	0.8	418.3	*679.5*	-	-	-
Savings accumulation	**0.5**	**232.8**	***204.4***	**1.2**	**840.7**	***1523.1***	**3.7**	**202.1**	***192.8***	**3.4**	**469.7**	***717.1***
Buffer stocks	0.3	139.7	*134.0*	1.0	381.9	*702.6*	3.2	203.4	*202.0*	3.2	282.4	*251.3*
Savings accounts in financial institutions	0.1	465.6	*164.6*	0.2	2037.0	*3277.3*	0.2	151.0	*185.1*	0.3	2718.0	-
Membership in savings and credit associations	-	-	-	-	-	-	0.1	176.7	*160.2*	-	-	-
Contract insurances	-	-	-	0.1	2910.0	.	0.1	407.7	*64.1*	-	-	-
Old age annuities	-	-	-	-	-	-	0.1	0.4	-	-	-	-
Others	**0.7**	**1.1**	***0.3***	**0.9**	**0.9**	***0.4***	**7.0**	**99.6**	***372.7***	**2.9**	**44.8**	***30.2***
Migration	0.0	-	-	0.1	0.0	-	3.1	120.0	*534.4*	0.5	58.0	*71.8*
Sharecropper tenancy	-	-	-	-	-	-	0.7	100.5	*128.0*	-	-	-
Medical treatment	-	-	-	-	-	-	0.3	48.7	*27.1*	-	-	-
Membership in occupational organisations	-	-	-	-	-	-	0.1	163.1	-	-	-	-
Preventive health practices	0.0	-	-	0.1	0.0	-	0.1	0.2	-	-	-	-
Marriage and extended family	-	-	-	-	-	-	0.1	72.5	-	-	-	-
Not specified	0.7	1.1	*0.3*	0.8	0.9	*0.4*	2.8	84.7	*174.5*	2.4	41.9	*21.1*

Note: [1] Households which perceived weather risk. [2] Regional poverty line (PPP$/person/month): 76.59 (TH) and 36.24 (VN)
Source: DFGFOR756 survey (2007) and (2008).

Descriptive results highlight the fact that risk perception is by far higher than shock experiences of the same events. In both countries, this discrepancy is found between the number of households having experienced shock and the number of households anticipating risks, frequency of shock incidences and frequency of expected risk events, and the severity in income and asset between past shocks and expected risks. Based on shock experiences between 2002 and 2008, the majority of households are mostly faced and concerned by weather adversities for the next 5 years. Moreover, the below poverty line group shows higher exposure and severity to weather shocks and also greater fear toward future weather risks in both countries. Despite high weather risk anticipation, only a relatively small proportion of households applied *ex-ante* mitigation strategies to prepare for weather risks. In Vietnam, the majority of households individually invests in assuring the security of homestead and jointly improves common infrastructure with other households. The same *ex-ante* actions are applied in Thailand together with income portfolio adjustment and savings accumulation as additional individual strategies. Although *ex-ante* risk mitigation is more undertaken by households in higher-income group in Thailand, poor Thai households invest much higher expenses on security of homestead and collective action than the non-poor who prefers income source diversification and building up savings.

In the next section, empirical models will be constructed to identify determinants that shape weather risk perception (research question (ii)), and analyze how weather risk perception, among other factors, influence the households' decision to apply any, as well as specific, *ex-ante* risk management strategies (research questions (iii) and (iv)).

4.3 Empirical models

In this section, empirical models are set up in order to identify possible linkages between past shock experience and future weather risk perception, and to clarify the role of weather risk perception in influencing households' decisions to apply *ex-ante* risk management strategies. From descriptive results presented so far, a large discrepancy between shock experience and risk perception as well as diverse country-specific *ex-ante* risk mitigation behaviors is recognized. The discrepancy can be explained by various theories which address the dynamic process of risk perception formation, including prospect theory and learning theory (Rogers 1997). Prospect theory focuses on the relationship between stimulus and response in the formation of risk perception. Risk perception, once formulated, is relatively stable and only changes in the event of intense shock experience (Rogers 1997). Learning theory addresses the process through which direct experience of events, together with additional information, beliefs and attitudes, are translated into personal perception (Bandura 1986). To reflect the process of

weather risk perception formation, empirical models should therefore take into account not only direct past experiences with weather shocks but also additional factors that assist weather-related information acquisition including factors that influence beliefs and attitudes toward weather risk.

Analogous to the modeling of *ex-post* shock coping-decision and choice of coping activity presented in chapter 3, households undergo some similar decision procedures before acting upon specific *ex-ante* risk mitigation measures. In addition, it is hypothesized that weather risk perception has an influence on the decision to use *ex-ante* weather risk mitigation strategies. Hence in this framework risk perception formulation (decision step 1) takes place prior to the application of mitigation action (decision step 2) and specification of mitigation strategies (decision step 3), respectively. As a result, three regression models are constructed to evaluate households' behavior in each of the three decision-making steps as follows.

In the first step households' weather risk perception is estimated while controlling for the short-term effect of weather-related shocks on households' risk perception as well as for other socio-demographic factors that construct and maintain risk expectations. The ordinary least squares (OLS) regression which is used for this purpose takes the following form:

$$R_i = \lambda S_i^w + \phi X_i^r + \rho Poor_i + \gamma P_p \qquad \text{-- (1)}$$

where *i* indexes household and R_i is an ordinal weather risk score which indicates the magnitude of aggregated weather risk which a household expects to happen in the future. In the household questionnaire respondents were asked to quantify both the expected frequency of each weather risk event which they expected to happen in a 5-year future reference period and the expected severity of each of these events. The expected severity was stated separately in terms of income and asset loss, and by using an ordinal scale from 0 (=no impact) to 3 (=high severity). The weather risk score of each risk event is computed by summing the expected severity of individual risk event multiplied by the expected frequency of the event. The sum of the weather risk scores of all expected weather risks of a household (as specified in Table 4.1a-c) gives R_i. Furthermore, S_i^w is a vector of weather shock incidences that a household experienced during 2002 and 2008 and X_i^r is a vector of socio-demographic characteristics of the interview respondent who estimated risk perception representatively for the household. To explicitly include vulnerability aspect of households, $Poor_i$ is a vector of dummy variables that defines poverty status of households to be either below or above regional poverty line. P_p is a vector of dummy variables in order to capture the effect of provinces and village characteristics. λ, ϕ, ρ and γ are the parameters to be estimated.

In the second step, households decide between *ex-ante* weather risk mitigating and non-mitigating action. The second regression model is accordingly set up to assess the probability to adopt any *ex-ante* risk mitigation action by applying a standard probit model,

$$\begin{aligned} Y_i^* &= \psi R_i + \phi X_i^h + \rho Poor_i + \gamma P_p + u_i \\ Y_i &= 1 \quad if \quad Y_i^* > 0 \\ Y_i &= 0 \quad otherwise \end{aligned} \qquad \text{-- (2)}$$

where *i* indexes household, Y_i^* is a latent bivariate decision variable that takes the value 1 if an *ex-ante* risk mitigation action is taken and 0 otherwise, R_i is the ordinal risk score which was used as dependent variable in the first-step regression, X_i^h is a vector of socio-demographic household characteristics, $Poor_i$ is a vector of poverty status, P_p is a vector of provincial/village dummy variables and u_i is a stochastic element. Instead of observing Y_i^*, a binary variable Y_i is observed which takes the value 1 if a household applies any *ex-ante* risk management strategy in order to cope with perceived weather risk. ψ, ϕ, ρ and γ are the parameters to be estimated (Wooldridge 2002).

In the third step, households decide on the specific type of *ex-ante* weather risk mitigating action. The third regression model is based on the assumption that the decisions of households to engage in the different strategies are correlated. Therefore a standard probit model is not suitable for making predictions about the joint probabilities of the relevant risk management strategy choices. As shown in section 4.2, collective action and investment activities are two relevant mitigation strategies are identified in Vietnam while income portfolio adjustment and savings accumulation are additional mitigation strategies in Thailand. Hence, different probit models must be used to reflect the number of relevant choices in each country. For Vietnamese households, a bivariate probit model is appropriate to allow for two *ex-ante* risk mitigation strategies. For Thai households, four different *ex-ante* risk mitigation measures are incorporated in a multivariate probit model. Consider the following stochastic functions, one for each risk management strategy choice from 1 to *J*.

$$\begin{aligned} Y_{1i}^* &= \psi_1 R_{1i} + \phi_1 X_{1i}^h + \rho Poor_i + \gamma_1 P_{1p} + u_{1i} \\ Y_{1i} &= 1 \quad if \quad Y_{1i}^* > 0 \\ Y_{1i} &= 0 \quad otherwise \end{aligned} \qquad \text{-- (3)}$$

$$\begin{aligned} Y_{2i}^* &= \psi_2 R_{2i} + \phi_2 X_{2i}^h + \rho Poor_i + \gamma_2 P_{2p} + u_{2i} \\ Y_{2i} &= 1 \quad if \quad Y_{2i}^* > 0 \\ Y_{2i} &= 0 \quad otherwise \end{aligned} \qquad \text{-- (4)}$$

$$\vdots$$

$$Y_{Ji}^{*} = \psi_J R_{Ji} + \phi_J X_{Ji}^{h} + \rho Poor_i + \gamma_J P_{Jp} + u_{Ji}$$
$$Y_{Ji} = 1 \quad if \quad Y_{Ji}^{*} > 0 \qquad \text{-- (5)}$$
$$Y_{Ji} = 0 \quad otherwise$$

where the variable coefficients and parameters are specified as the standard probit model in the second step. Both bivariate and multivariate probit model are estimated by means of maximum likelihood methods and both models allow for correlation of the error terms which have (multivariate) normal distribution (Greene 2003).

Nevertheless a caution of endogeneity must be taken into consideration. Since it is hypothesized that risk perception affects *ex-ante* risk management behavior, the *ex-ante* risk mitigation models in step 2 and step 3 control for risk perception which is shaped by past shock experience. In this regard, a difference must be made between short-term and long-term shock experience. While short-term shock experience directly shapes risk perception, it indirectly affects *ex-ante* risk management behavior through risk perception formulation. On the other hand, long-term shock experience may also directly affect *ex-ante* risk management behavior as households with more long-term shock experiences might be more acquainted in finding and applying risk management strategies. However, the available data only permits short-term shock experience (i.e. between 2002 and 2008), long-term shock experience is not captured from the models. Therefore, an endogeneity bias could exist because the *ex-ante* risk management models in this framework do not control for long-term shock experience. Also note that the number of observations included in the regression models is smaller than the initial sample size since some households have been excluded from the analysis in order to ensure the normal distribution of all variables.

4.4 Results

In the following the outcome of the econometric analysis is presented. All models have been tested for multicollinearity between explanatory variables and no problematic collinear relationships could be detected. The regression estimates of the presented models are adjusted for heteroskedasticity. Testing for specification error by means of a link test indicated that no important independent variables have been omitted.

4.4.1 Weather risk perception formulation

For the first step of weather risk perception formulation, descriptive statistics of variables used in the OLS regression are summarized in Table 4.3. Taking into account past weather shock frequency and severity, somewhat higher weather risk perception scores is indicated among Vietnamese households than in Thailand. In both countries, poor households below poverty line have higher weather risk perception score than the above poverty line households due to greater number of weather shocks of high and medium severity. About 80% of all respondents engage in agriculture as main occupation. Most of Vietnamese respondents are male compared to Thai respondents who are predominantly female. On average, Vietnamese respondents are male, 2 years younger, have 2 years more education and belong to socio-political organization more than Thai respondents. Identical regression was applied for both countries except that ethnicity and a multiplicative term have been added to the Vietnamese model in order to capture the ethnic diversity and to interact highly severe climate shocks with the Dak Lak province dummy variable.

Table 4.3: Descriptive statistics of OLS regression variables

	Thailand (n = 1555)				**Vietnam (n = 1651)**			
	Below poverty line[a] (n=627)		Above poverty line[b] (n=928)		Below poverty line[a] (n=1314)		Above poverty line[b] (n=337)	
	Mean	*Std. Dev.*	Mean	*Std. Dev.*	Mean	*Std. Dev.*	Mean	*Std. Dev.*
Weather risk perception (Ordinal score)	19.31	*16.05*	17.24	*16.55*	23.34	*22.13*	15.81	*19.12*
Respondent characteristics								
Agricultural occupation (1=Yes)	0.81	*0.40*	0.80	*0.40*	0.82	*0.39*	0.75	*0.43*
Member in socio-political organization (1=Yes)	0.07	*0.26*	0.12	*0.33*	1.28	*0.45*	1.23	*0.42*
Age (Years)	50.30	*13.64*	50.92	*12.60*	47.18	*14.23*	48.44	*13.56*
Age squared (Years)	2716.15	*1436.71*	2751.72	*1315.07*	2427.98	*1496.77*	2529.96	*1400.22*
Ethnicity (1=Kinh)	-[b]	-[b]	-[b]	-[b]	0.83	*0.38*	0.94	*0.23*
Education (Years)	4.82	*2.36*	5.54	*3.40*	6.39	*3.70*	8.82	*3.51*
Gender (1=Male)	0.40	*0.49*	0.44	*0.50*	1.47	*0.50*	1.43	*0.50*
Province dummies								
Buriram (TH)/ Ha Tinh (VN) (1=Yes)	0.45	*0.50*	0.43	*0.49*	0.37	*0.48*	0.39	*0.49*
Nakhon Phanom (TH) / Dak Lak (VN) (1=Yes)	0.20	*0.40*	0.16	*0.37*	0.34	*0.47*	0.50	*0.50*
Weather shock incidents 2002-2008								
Weather shocks of high severity (Number)	0.67	*0.83*	0.55	*0.79*	0.75	*0.82*	0.53	*0.73*
Weather shocks of medium severity (Number)	0.33	*0.65*	0.29	*0.55*	0.27	*0.53*	0.24	*0.47*
Interaction terms								
Dak Lak * Weather shocks of high severity	-[b]	-[b]	-[b]	-[b]	0.34	*0.69*	0.31	*0.59*

Note: [a] Regional poverty line (PPP$/person/month): 76.59 (TH) and 36.24 (VN) [b] Variables irrelevant for Thailand.
Source: DFGFOR756 survey (2007) and (2008).

Results of the OLS regression of weather risk perception[33] are presented in Table 4.4. The reported F-test indicates that the independent variables are jointly significant. The estimated effects of the constitutive terms must be interpreted with care as the effect of one constitutive term on the dependent variable is conditional upon the value of the other independent constitutive terms (Wooldridge 2000).

Results from both countries indicate that households which experienced more frequent adverse weather incidences during the last 7 years are more sensitive and pessimistic to future weather risk appraisal than households which undergone fewer or no climate shocks, a finding similar to the outcome of Paul's (1984) study. In both countries, poverty status is found to be positively related to the pessimistic outlook toward future weather risks. Below poverty line households are more likely to perceive high weather risks than households whose income lie above poverty line. This relationship is significant especially in Vietnam.

Table 4.4: OLS regression of weather risk perception against socio-demographic characteristics

OLS weather risk perception	Thailand		Vietnam	
	Coef.	t-value	Coef.	t-value
Respondent characteristics				
Household below poverty line (1=Yes)	1.05	1.14	2.78	1.79 *
Agricultural occupation (1=Yes)	2.47	2.62 **	6.07	3.71 ***
Member in socio-political organization (1=Yes)	0.76	0.61	4.24	3.55 ***
Age (Years)	-0.01	-0.03	0.39	2.30 **
Age squared (Years)	0.00	-0.11	0.00	-2.40 **
Ethnicity (1=Kinh)	-[a]	-[a]	1.19	1.00
Education (Years)	-0.07	-0.53	0.17	1.32
Gender (1=Male)	-0.26	-0.31	-1.51	-1.60
Province dummies				
Buriram (TH) / Ha Tinh (VN) (1=Yes)	4.82	4.83 ***	-1.55	-0.70
Nakhon Panom (TH) / Dak Lak (VN) (1=Yes)	2.36	1.96 *	-18.07	-8.04 ***
Weather shock incidents 2002-2008				
Weather shocks of high severity (Number)	5.14	7.36 ***	8.79	7.48 ***
Weather shocks of medium severity (Number)	2.66	4.22 ***	1.40	1.20
Interaction terms				
Dak Lak * Climate shocks of high severity	-[a]	-[a]	-6.36	-4.98 ***
Constant	10.98	1.56	3.39	0.60
P > F (joint significance)	0.00		0.00	
R^2	0.10		0.28	
n	1555		1651	

Note: [a] Variables irrelevant for Thailand. *P<0.1, **P<0.05, ***P<0.01
Source: Own calculation.

Weather risk perception of Thai households is especially responsive to past weather shock experiences with both high and medium subjective severity assessment. Moreover, households in the provinces of Buriam and Nakhon Phanom generally perceive weather risk to be higher

[33] Despite some variables being non-significant, this OLS regression model seems to be the most adequate compared to other model specification variations.

than households in the province of Ubon Ratchathani. This indicates differences in micro-climatic conditions and socio-cultural factors between provinces.

In Vietnam, weather shocks of high subjectively perceived severity are found to be significantly and positively correlated with the level of weather risk perception for households in provinces other than Dak Lak. For households in Dak Lak province a similar positive effect is indicated after calculating the relevant marginal effect, however the size of the effect is comparatively small. This means that the weather risk perception of households in Dak Lak province increases to a smaller extent as a response to experiencing highly severe climate shocks. This may be due to the geographical location of Dak Lak in Vietnam's Central Highlands region that is less prone to cyclones and tropical storms than coastal provinces. Thus, households might see extreme weather conditions as rare events that are unlikely to occur again in the near future. Results furthermore indicate that household respondents in Dak Lak province reveal a considerable and significant lower perception of weather risk than household from Thua Thien Hue province in the absence of highly severe climate shocks. No significant relationship can be identified with regards to weather shocks of lower subjectively perceived severity, which emphasizes the importance of differentiating between shock events of different severity levels.

Further results show that agricultural occupation of the respondent in both countries increases the level of weather risk perception, suggesting that household members who are actively engaged in agriculture are more aware of the hazards that climatic fluctuations can bring about regardless of any actual weather shock experience. Furthermore, two other socio-demographic characteristics of respondents are found to have significant influence on weather risk perception in Vietnam. Membership in a socio-political organization, such as the Communist Party or the Veteran's Union, is indicated to be positively related with perceived weather risk. As social learning theory suggests, beliefs of individuals are not only shaped by self-experience but also by observing and retrieving information from others (Rotter 1954, Bandura 1971). Those Vietnamese farmers who have a larger personal network through which they can access information from both other farmers and governmental sources may perceive the risk of being affected by weather adversities to be higher than farmers who can only rely on their own experience. Moreover, older Vietnamese respondents are likely to evaluate a higher perception of weather risk which may be explained by an increasing preoccupation for their family and a more profound long-term experience of the effects of weather shocks.

4.4.2 Determinants of ex-ante weather risk mitigation action

For the second and third step of *ex-ante* weather risk mitigation behavior analysis, Table 4.5 summarizes descriptive statistics of variables used in the standard, bivariate and multivariate probit regressions. Depending on model type, each regression draws on different dependent variables but all three models regress on the same set of explanatory variables. Note that the explanatory variables vary slightly to reflect the country-specific situations. For example, it is more difficult in Vietnam to sell or buy land as it is constrained by political conditions. Hence, wealth variable applied in Thai model (see chapter 3) contains value of productive and consumption assets, as captured in tangible assets, and also includes value of the house, own land, livestock and financial savings which are less applicable in Vietnam. To maintain cross-country comparability, land size is used as a reasonable proxy for land value and included as a separate variable in Vietnamese model. Although the majority of households rely on agriculture as main income source, simultaneous off-farm and non-farm employment are common among Thai households. Hence, "off-farm employment as main option" village variable in Vietnamese model is replaced with ratio of "engagement in agriculture" household characteristic in Thai model. Furthermore, the sample size in Vietnam is slightly reduced due to the exclusion of income portfolio adjustment and savings accumulation strategies as well as non-specified strategies.

In both countries, household sizes in general are similar but larger households are found among the poor by one more member. However, household heads in Thailand are 6 years older than the Vietnamese heads. Education level is slightly higher in Vietnam but poor households usually one fewer school year than non-poor households in both countries. Furthermore, non-poor households possess twice as much asset than the poor, measured either in wealth per capita in Thailand or in tangible assets value in Vietnam. With regards to income, although Thai households have higher income level than Vietnamese households, income inequality is more pronounced where the poor earns 7.5 times less than the non-poor compared to 4.5 times in Vietnam. In Vietnam, agriculture represents an important source of employment as about 70% of Vietnamese household members engage in agriculture compared to about 50% in Thailand although the same shares of poor and non-poor households are working in agriculture in both countries. A remarkable observation is that Vietnamese households spend more months working in off-farm employment than Thai households. Moreover, non-poor households engage more in off-farm employment than the poor ones. Furthermore, village characteristics show a more developed infrastructure in Thailand than in Vietnam, measured by traveling time to district town and market.

Table 4.5: Descriptive statistics of Probit regression variables to explain the application of *ex-ante* weather risk mitigation

Variables	Thailand (n=1555)				Vietnam (n=1476)			
	Below poverty line[a] (n=627)		Above poverty line[a] (n=928)		Below poverty line[a] (n=1190)		Above poverty line[a] (n=286)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Dependent variables								
Ex-ante climate risk mitigation (1=Yes)	0.17	0.38	0.19	0.39	0.32	0.47	0.24	0.43
Collective action (1=Yes)	0.08	0.27	0.09	0.28	0.10	0.30	0.09	0.28
Investment (1=Yes)	0.04	0.18	0.04	0.20	0.13	0.34	0.11	0.32
Diversification (1=Yes)	0.03	0.17	0.03	0.16	-[c]	-[c]	-[c]	-[c]
Savings (1=Yes)	0.01	0.11	0.02	0.16	-[c]	-[c]	-[c]	-[c]
Explanatory variables								
Household characteristics								
Education (Years)	8.24	3.14	9.11	4.07	9.03	3.33	10.67	3.23
Wealth per capita (PPP$)	36134.00	35018.38	71682.79	73231.47	-[c]	-[c]	-[c]	-[c]
Tangible assets value (PPP$)	-[b]	-[b]	-[b]	-[b]	646.62	614.68	1399.48	872.72
Household size	4.44	1.74	3.86	1.70	4.53	1.71	3.48	1.35
Average monthly per capita income (PPP$)	37.00	30.54	280.61	495.39	14.28	9.08	66.31	37.22
Engagement in agriculture (%)	0.48	0.27	0.52	0.30	0.74	0.37	0.66	0.41
Off-farm employment (Months)	9.60	10.84	12.83	11.34	12.20	10.04	13.59	11.04
Age of household head (Years)	54.98	13.44	56.13	12.83	48.67	13.80	49.93	13.16
Age of household head squared (Years)	3202.79	1550.29	3312.36	1517.93	2558.96	1490.62	2665.62	1402.75
Land size (ha)	-[b]	-[b]	-[b]	-[b]	0.06	0.06	0.08	0.07
Ethnicity of household head (1=Kinh)	-[b]	-[b]	-[b]	-[b]	0.82	0.38	0.95	0.22
Weather risk score	19.31	16.05	17.24	16.55	25.77	21.86	18.63	19.45
Village/province characteristics								
Time to district town (Minutes)	22.87	13.08	21.71	12.24	33.29	21.34	33.87	21.29
Time to marktet (Minutes)	18.47	15.06	15.67	13.53	15.24	9.57	15.41	8.98
Off-farm employment as main option (1=Yes)	-[b]	-[b]	-[b]	-[b]	0.44	0.50	0.41	0.49
Buriram (TH) / Ha Tinh (VN) (1 = Yes)	0.45	0.50	0.43	0.49	0.36	0.48	0.42	0.49
Nakhon Panom (TH) / Dak Lak (VN) (1 = Yes)	0.20	0.40	0.16	0.37	0.34	0.47	0.49	0.50

Note: [a] Regional poverty line (PPP$/person/month): 76.59 (TH) and 36.24 (VN)
[b] Variables irrelevant for Thailand. [c] Variables irrelevant for Vietnam.
Source: DFGFOR756 survey (2007) and (2008).

Table 4.6 shows the results of the probit regression of households' application of any *ex-ante* weather risk management strategies in 2008. In both countries it is indicated that the degree of weather risk perception is significantly increasing the probability of households to use any such strategies, although the magnitude of this effect is relatively small.

In Thailand, the decision to adopt *ex-ante* risk mitigation strategies are significantly and negatively influenced by household income level suggesting that higher-income households are less likely to apply precautionary measures against weather risks, however the marginal effect is rather small. In addition, negative relationship between poverty status and *ex-ante* mitigation action is found although it is not significant. Moreover, households in the provinces of Ubon Ratchathani and Buriram are more likely to take up *ex-ante* risk mitigation actions than households in Nakhon Phanom province.

In Vietnam, Poor households are more like to take *ex-ante* risk mitigation action as shown by a positive, although not significant, sign of poverty status dummy variable. Location characteristics in Vietnam are significantly decreasing the likelihood of applying *ex-ante* weather risk management strategies, with households living in Dak Lak province reveal a probability that is about 43% lower than in the province of Thua Thien Hue. The reason for this large difference is to be explored in the bivariate probit regressions. Additional covariates which have a significant effect on households' decision to use *ex-ante* weather risk management strategies are the ethnicity of the household head and the engagement of the household in off-farm wage- or non-farm self-employment. Belonging to Vietnam's ethnic Kinh majority increases the probability of applying these strategies by about 8% which might suggest that ethnic minorities have a relatively poor access to the knowledge and resources required to apply risk mitigation techniques. Contrary, income source diversification, i.e. being engaged more months in off-farm wage- or non-farm self-employment, lowers the likelihood of *ex-ante* weather risk management strategy use, indicating that such households only depend on their agricultural production to a smaller extent and can still count on their non-agricultural income sources when weather calamities damage their crops or livestock (Phung Duc and Waibel 2010).

Table 4.6: Standard probit regression of household use of *ex-ante* weather risk management strategies in 2008 against socio-demographic characteristics

Probit: Ex-ante weather risk mitigation (1=Yes)	Thailand		Vietnam	
	Coef.	dF/dx	Coef.	dF/dx
Household characteristics				
Household below poverty line (1=Yes)	-0.1250	-0.0311	0.0212	0.0046
Education (Years)	0.0156	0.0039	0.0025	0.0005
Wealth per capita (PPP$)	0.0000	0.0000	-[b]	-[b]
Tangible assets value (PPP$)	-[a]	-[a]	0.0001	0.0000
Household size	-0.0077	-0.0019	0.0383	0.0084
Average monthly per capita income (PPP$)	-0.0003 *	-0.0001	-0.0003	-0.0001
Engagement in agriculture (%)	0.1432	0.0361	-[b]	-[b]
Off-farm employment (Months)	0.0004	0.0001	-0.0087 *	-0.0019
Age of household head (Years)	-0.0230	-0.0058	0.0091	0.0020
Age of household head squared (Years)	0.0001	0.0000	-0.0001	0.0000
Land size (ha)	-[a]	-[a]	0.7916	0.1739
Ethnicity of household head (1=Kinh)	-[a]	-[a]	0.4622 *	0.0840
Weather risk score	0.0045 **	0.0011	0.0039 *	0.0009
Village/province characteristics				
Time to district town (minutes)	0.0000	0.0000	0.0013	0.0003
Time to marktet (minutes)	-0.0055	-0.0014	-0.0042	-0.0009
Off-farm employment as main option (1=Yes)	-[a]	-[a]	-0.1422	-0.0308
Buriram (TH) / Ha Tinh (VN) (1 = Yes)	-0.0965	-0.0242	0.0794	0.0176
Nakhon Panom (TH) / Dak Lak (VN) (1 = Yes)	0.3119 **	0.0862	-2.3357 ***	-0.4278
Constant	-0.2258		-0.9276	
P > F (Wald test)	0.0001		0.0000	
n	1555		1476	

Note: [a] Variables irrelevant for Thailand. [b] Variables irrelevant for Vietnam.
*P<0.1, **P<0.05, ***P<0.01. dF/dx indicates the marginal effect of a one-unit change in the explanatory variable on the probability to use any *ex-ante* weather risk management strategies.
Source: Own calculation.

4.4.3 Choice of ex-ante weather risk mitigation measures

The outcome of the bivariate probit regressions of Vietnamese households' use of collective action and investment activity as *ex-ante* weather risk management strategies are shown in Table 4.7. The significant negative sign of rho(ρ), which measures the correlation between the errors of the two mitigation action equations, indicates that the decision to apply one of the two risk management strategies reduces the likelihood of applying the other one. The significant coefficient also indicates that using the bivariate probit approach is indeed more appropriate than estimating two separate standard probit models.

Results indicate that a higher weather risk score is significantly increasing the probability that households engage in collective action to improve as well as to maintain common infrastructure and resource to reduce their vulnerability to weather risk. However, no significant relationship is found with respect to investment activity. The reasons for this difference might be that collective action can be organized more spontaneously when the risk perception level of a group of households is high, requiring mainly labor input from the household side. On the other hand, investment activity depends more on long-term strategic decisions of households which often

have a limited ability to invest due to financial constraints. Again, location factors play a key role in determining the adoption of these main *ex-ante* weather risk management strategies. In Dak Lak, households are significantly less likely to apply either of the two strategies as compared to households in Thua Thien Hue. In Ha Tinh, however, investment activities are significantly more likely than in Thua Thien Hue.

Poverty status and per capita income variables show negative but non-significant signs to both strategies. The estimates of the effect of tangible assets value on the application of the most frequently applied *ex-ante* weather risk management strategies yield contrary signs. Tangible asset value is significantly positively related to the engagement in collective action, an expected outcome since a household with more valuable tangible assets should have a higher incentive to protect its assets by applying *ex-ante* weather risk management strategies. However, a significant negative relationship is indicated between tangible asset value and investment actions. Given the above reasoning, this result is unexpected and requires further scrutiny. Investment activity is furthermore significantly positively correlated with land size, another possible indicator for the value of household assets.

Table 4.7: Bivariate probit regressions of Vietnamese household use of collective action and investment activity as *ex-ante* weather risk management strategies against socio-demographic characteristics

Vietnam: Bivariate probit	Collective action		Investment activity	
(n=1476)	Coef.	dF/dx	Coef.	dF/dx
Household characteristics 2007/2008				
Household below poverty line (1=Yes)	-0.00104	-0.0001	-0.0904	-0.0001
Education (Years)	0.001351	0.0001	0.01812	0.0000
Tangible assets value (PPP$)	0.000369 ***	0.0000	-0.0002 *	0.0000
Number of household members	0.054351	0.0034	-0.0353	0.0000
Average monthly per capita income (PPP$)	-0.00086	-0.0001	-0.0023	0.0000
Off-farm employment (Months)	-0.00948	-0.0006	0.00241	0.0000
Age of household head (Years)	-0.00592	-0.0004	0.01203	0.0000
Age of household head squared (Years)	3.26E-05	0.0000	-0.0002	0.0000
Land size (ha)	-2.71994	-0.1713	2.1966 **	0.0030
Ethnicity of household head (1=Kinh)	0.298643	0.0154	0.47076	0.0004
Weather risk score	0.010245 ***	0.0006	-0.0012	0.0000
Village/province characteristics				
Off-farm employment = main option (1=Yes)	-0.39725	-0.0239	0.21956	0.0003
Time to district town (minutes)	-0.00122	-0.0001	0.00361	0.0000
Time to marktet (minutes)	0.005487	0.0003	-0.0009	0.0000
Ha Tinh dummy (1=Yes)	0.190242	0.0125	0.46861 ***	0.0008
Dak Lak dummy (1=Yes)	-1.5047 ***	-0.0903	-6.0304 ***	-0.1639
Constant	-1.77908 **		-1.8098 ***	
P > F (Wald test) = 0.0000				
Rho (ρ) = -0.2641639***				

Note: *P<0.1, **P<0.05, ***P<0.01. dF/dx indicates the marginal effect of a one-unit change in the explanatory variable on the probability to use collective action and investment activity, respectively, as *ex-ante* climate risk management strategy.
Rho(ρ) measures the correlation between the residuals of the two mitigation action equations.
Source: Own calculation.

For Thai households, Table 4.8 summarizes the results of the multivariate probit model which further reveals specific relationships between the same set of variables from the previous probit model and the adoption probability of four major *ex-ante* weather risk mitigation activities, i.e. (i) collective action, (ii) investment activity, (iii) income portfolio adjustment and (iv) savings accumulation. Analogous to the bivariate probit model (see Table 4.7), rho measures the correlation between the residuals of the four mitigation action equations. For example, a negative sign of rho21 indicates a substitution relationship between collective action and investment activity such that the application of one strategy reduces the likelihood of applying the other one. Similar substitution relationships are detected between collective action and savings accumulation (negative rho41), investment activity and income portfolio adjustment (negative rho32), and investment activity and savings accumulation (negative rho 42). Complementary relationship between mitigation strategies are found between collective action and income portfolio adjustment (positive rho31) and between income portfolio adjustment and savings accumulation (positive rho43). Although none of the residual correlations are significant, the chi-square likelihood ratio test of all rho is significant indicating that using the multivariate probit approach is an appropriate approach as opposed to four separate standard probit models.

The most striking result is weather risk score is found to have positive influence on all strategies. Results confirm the effect of weather risk perception is significant on collective action as well as individual household income portfolio adjustment. Households which perceive weather risk to be threatening are more likely to join cooperation with other households to improve and maintain common infrastructure and resources. Moreover, they are more likely to diversify agricultural portfolio and income sources to cushion negative effects of risks on income and asset. A positive but non-significant relationship is also found between weather risk score and investment activity and savings accumulation.

Poverty status indicates negative relationship with all four mitigation actions. This finding confirms the result of previous standard probit model, although non-significant, demonstrating that households who belong to the poor group (i.e. below poverty line), are less likely to take any *ex-ante* risk mitigation action. In this multivariate probit model, a significant negative correlation of poverty status is detected for savings accumulation. Furthermore, the variable income per capita shows negative signs for all four mitigation actions and verifies the significant negative relationship between income level and mitigation action probability in the previous standard probit model. The multivariate probit model further shows that higher-income households are significantly less likely to take investment activity against weather risks.

Engagement in agriculture significantly increases the likelihood that a household would invest in security of homestead as well as physical and human capital. However, significant negative relationships are found between engagement in agriculture and off-farm employment and savings accumulation. Households that rely more on agricultural as well as off-farm employment are less likely to build up savings to prepare for weather risks. Off-farm employment, on the contrary, increases the probability that a household would participate in collective action and adjust income portfolio, although the correlation is not significant.

Village and province characteristics also play a role in making a choice of *ex-ante* mitigation strategy. Closer distance to district town significantly encourages adjustment of income portfolio due to greater possibility to find off-farm and non-farm employment. Furthermore, households living in Ubon Ratchathani are more likely to join collective action and to invest than in other provinces while households living in Buriram and Nakhon Phanom are more likely to adjust income portfolio and build up savings.

In summary, the results of three regression models provide a preliminary insight to the formulation and the role of weather risk perception on the application of *ex-ante* weather risk management strategies among rural households in Thailand and Vietnam. The empirical approach carried out in this study attempts to address the incorporation of risk perception formation in the *ex-ante* weather risk prevention analysis. Despite some shortcomings in the model specifications, results point out to the significant relevance of subjective risk perception on *ex-ante* risk mitigation actions. As shown by the first OLS regression, more frequent and severe experience with past weather shocks significantly increases weather risk perception. The degree of risk perception also increases with the poverty status of households and agricultural occupation of the respondent. The following standard probit regression further highlights the significant positive influence of weather risk perception on the likelihood of households to use any *ex-ante* risk mitigation actions. In Thailand, precautionary measures against weather risks are significantly less likely among higher-income households. In Vietnam, location factors, ethnicity and off-farm employment are additional important determinants for the use of *ex-ante* risk prevention actions.

Positive influence of weather risk perception is further observed in bivariate (Vietnam) and multivariate (Thailand) probit regression models concerning the decision-choice of specific *ex-ante* risk mitigation strategies. In particular, the probability that a household would participate in collective action to improve infrastructure and common resources significantly increases with the degree of weather risk perception in both countries. With increasing weather risk anticipation Thai households significantly adjust household income portfolio in addition. Poverty status and household income generally indicate negative relationship with all mitigation

actions in both countries. In Thailand, while investment activity is encouraged by agricultural engagement, savings accumulation is discouraged by employment in agricultural and off-farm sector. In Vietnam, household with large assets tend to engage more in collective action whereas investment activity increases with land size. In addition, provincial location and infrastructure factors are also important on the choice of *ex-ante* risk measures in both countries.

Table 4.8: Multivariate probit regressions of Thai household use of major *ex-ante* weather risk management strategies against socio-demographic characteristics

Wald chi2(56) = 183.22 Log pseudolikelihood = -505372.02
Prob > chi2 = 0.0000 SML, # draws = 40

Thailand: Multivariate probit	Collective action		Investment activity		Income portfolio adjustment		Savings accumulation	
(N = 1530)	Coef.	Marginal effect	Coef.	Marginal effect	Coef.	Marginal effect	Coef.	Marginal effect
Household characteristics								
Household below poverty line (1 = Yes)	-0.0532	-0.0076	-0.0843	-0.0067	-0.0027	-0.0002	-0.5079 ***	-0.0184
Education (years)	0.0148	0.0021	0.0240	0.0019	-0.0125	-0.0007	0.0108	0.0004
Wealth per capita (PPP$)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Household size	0.0299	0.0043	-0.0072	-0.0006	-0.0148	-0.0008	-0.0151	-0.0005
Average monthly per capita income (PPP$)	-0.0002	0.0000	-0.0004 *	0.0000	-0.0003	0.0000	-0.0009	0.0000
Engagement in agriculture (%)	0.2672	0.0382	0.5526 ***	0.0436	0.0247	0.0014	-0.6155 *	-0.0224
Off-farm employment (Months)	0.0001	0.0000	-0.0026	-0.0002	0.0026	0.0001	-0.0283 ***	-0.0010
Age of household head (Years)	-0.0232	-0.0033	-0.0238	-0.0019	-0.0445	-0.0025	0.0287	0.0010
Age of household head squared (Years)	0.0002	0.0000	0.0002	0.0000	0.0004	0.0000	-0.0004	0.0000
Weather risk score	0.0064 **	0.0009	0.0013	0.0001	0.0124 ***	0.0007	0.0028	0.0001
Village/Province characteristics								
Time to district town (Minutes)	0.0015	0.0002	0.0051	0.0004	-0.0161 **	-0.0009	-0.0038	-0.0001
Time to market (Minutes)	-0.0041	-0.0006	-0.0057	-0.0004	0.0021	0.0001	-0.0101	-0.0004
Buriram dummy (1 = Yes)	-0.3633 ***	-0.0520	-0.5029 ***	-0.0397	0.7974 ***	0.0449	0.4056	0.0147
Nakhon panom dummy (1 = Yes)	0.0202	0.0029	-0.0461	-0.0036	0.7679 ***	0.0432	0.7844 ***	0.0285
Constant	-1.0062		-1.2591		-1.1398		-1.9828	
atrho21	-0.0976	atrho32	-0.1286	rho21	-0.0973	rho32	-0.1279	
atrho31	0.0578	atrho42	-0.2872	rho31	0.0577	rho42	-0.2795	
atrho41	-0.0383	atrho43	0.0124	rho41	-0.0383	rho43	0.0124	

Likelihood ratio test of rho21 = rho31 = rho41 = rho32 = rho42 = rho43 = 0: chi2(6) = 1.0e+06 Prob > chi2 = 0.0000

Note: atrho are transformations of rho that are used in the estimation process. rho measures the correlation between the between the residuals of the four mitigation action equations.
Source: Own calculation.

4.5 Summary and conclusion

With the majority of poor and vulnerable households living in risky areas subject to increasing adverse weather change, effective social risk management must recognize short-term weather risk and especially weather risk perception as an important factor within the context of poverty alleviation of rural households. This chapter presents preliminary yet important insights into the relationship between shock experience, risk perception formation and the influence of risk perception on the use of *ex-ante* risk management strategies with regards to weather risk (specific research objective (II)). The empirical findings offer a cross-country analysis based on panel data collected from almost 4,400 households in six provinces in Northeast Thailand and Central Vietnam.

Concerning the status of weather shock experience during 2002 and 2008, weather risk perception anticipated for the next 5 years and *ex-ante* risk management currently applied (research question (i)), it is indicated that households in both countries are affected by different types of shocks among which weather calamities (predominantly drought, flooding and heavy rainfall) rank highest followed by socio-demographic shocks (mainly illness of household members). Furthermore, a large share of households in Thailand experienced economic shocks especially price fluctuations of production inputs and outputs, whereas Vietnamese households are more prone to biological shocks, such as crop pests and livestock diseases. On average households in both countries experienced two weather shocks between 2002 and 2008 with Vietnamese households reporting a higher average subjective severity. The comparison of poverty status between below and above income poverty line reveals that the poor are exposed to weather and economic shocks substantially more than the non-poor in both countries.

Compared to the observed shock experience households appear to be relatively pessimistic with regards to their perception of respective future risk. A large discrepancy between shock experience and risk expectation in terms of share of households expecting future risk and the anticipated frequency and severity of risk is observed. This points out the existence of factors other than past weather shock experience to be additional determinants of weather risk perception. In both countries the expected frequency and severity of risks is highest for weather events. In terms of expected severity households in both countries expected the adverse effects of risks to be higher on income than on assets. For all future risk events, especially weather risks, poor households are more pessimistic in terms of expected risk frequency and risk severity than non-poor households.

Despite substantial weather risk anticipation, only about 20% of Thai and 30% of Vietnamese and households applied respective precautionary measures. The main *ex-ante* weather risk management strategies which rural households in the study areas apply are (i) engagement in

collective action to build infrastructure and manage common property resource, (ii) investment in homestead security as well as physical and human capital, (iii) income portfolio adjustment through diversification of agricultural production and income source, and (iv) savings accumulation. While the collective action and investment activity are most common in both countries, income portfolio adjustment and savings accumulation are additionally relevant for Thai households. For every strategy, *ex-ante* mitigation action is used by poor households more often than non-poor households in Vietnam whereas the opposite relationship is found in Thailand. On average, Thai households spend more on risk prevention expenses than the Vietnamese. For Thailand, the largest spending is indicated for investment in the security of homestead where the poor spend essentially more on this mitigation measure than the non-poor. On the other hand, non-poor Vietnamese households emphasize on savings accumulation and investment activities more than the poor.

To evaluate households' decision-making behavior, three regression models are constructed corresponding to risk perception formulation (decision step 1: OLS regression) which takes place prior to the application of mitigation action (decision step 2: standard probit regression) and specification of mitigation strategies (decision step 3: bivariate- and multivariate probit regression), respectively. Results of OLS regression identify frequency of weather shock experience of high and medium subjective severity, poverty status (below poverty line), agricultural occupation, membership in socio-political organization and age of the respondent as well as location factor to positively and significantly increase weather risk perception (research question (ii)). Estimations of standard probit regression further highlights the significant positive influence of weather risk perception on the application of any *ex-ante* weather risk prevention action (research question (iii)). In addition, the use of *ex-ante* weather risk mitigation measures significantly decreases with increasing income level of Thai households whereas location factors, ethnicity and off-farm employment are important mitigation determinants for Vietnamese households. Weather risk perception further indicates positive influence on the choice of specific main *ex-ante* weather risk management strategies in general (research question (iv)), although the direction and significance of influence is diverse across types of mitigation measures and countries. Results of bivariate (Vietnam) and multivariate (Thailand) probit regression models show that the households' decision likelihood to engage in collective action increases with rising risk perception in both countries. In Thailand, similar significant positive influence of weather risk perception is found for income portfolio adjustment while no such link is found with regards to the decision to invest and accumulate savings. Income level and the degree of agricultural engagement can be further identified as significant determinants of investment activity while savings accumulation is significantly influenced by poverty status, engagement in agriculture and off-farm employment of household

members. In Vietnam, asset values, land size and location factors stand out as the most important factors for collective action and investment activity.

Rural households in the study areas translate their experience of weather shocks into weather risk perception and to some extent apply precautionary measures against future weather risks, suggesting that they are to a considerable extent aware of common climatic hazards in their regions. Risk communication processes between disaster management institutions and rural households thus can build on such knowledge. The application of main *ex-ante* weather risk mitigation strategies depends on the level of weather risk perception as well as other country-specific determinants. In Vietnam, since the level of weather risk perception leads directly to collective action, communication of risk awareness should therefore be accompanied by strengthening community capacity and enhancing inter-household cooperation to jointly prepare for weather risks. However, policy makers should be aware of inter-provincial including ethnic differences in the promotion of weather risk management. In Thailand, high weather risk awareness induces collective action as well as income portfolio adjustment as individual measure. Rural development policy should assist households by improving infrastructure and provide knowledge, extension services and opportunity for agricultural diversification and off-farm employment. The low share of farm households using alternative individual *ex-ante* risk mitigation options, particularly investment activity in both countries and savings accumulation in Thailand, points to a possible existence of financial barriers to apply such strategies. Public insurance scheme focusing on weather risk, such as crop insurance in case of weather calamity and budget funds for homestead security construction, is a possible additional social risk safety net. More importantly, public support must focus on poor and households as they are mostly affected by past weather shocks and feared by future weather risks but are least equipped to implement *ex-ante* risk mitigation strategies.

This study provides a comprehensive starting point for *ex-ante* weather risk mitigation analysis focusing on vulnerable rural households based on the implication of weather risk perception. Nevertheless, low and non-significance of many variables in the standard (univariate), bivariate and multivariate probit regressions requires further improvement of the model specification. In particular, variation of optional model specifications and testing for aggregation errors are necessary to allow for a better judgment of further in-depth analysis. Additionally, further step to analyze the repercussion effect of *ex-ante* weather risk mitigation on the outcome level of vulnerability to poverty is recommended. Establishing such link directly between weather risk and poverty will allow drawing conclusions on the welfare implication of weather risk perception and facilitate the design of social risk management policies. Comparison of several vulnerability concepts such as the standard vulnerability as expected poverty (Chaudhuri et al. 2002) and the more refined concept of vulnerability as expected deprivation (Calvo and Dercon

2007b) will enhance the comprehensiveness of poverty reduction and social risk management strategy. In addition, conventional historical data on weather variations may be included in the models to fully capture the objective and subjective components of weather risks.

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Chapter 5

Impact of Price Shocks on Rural Farm Household Vulnerability to Poverty

5.1 Introduction

In developing countries, increasing economic integration through trade liberalization at international, national and regional level has contributed to high rates of economic growth and reduction of poverty (Ahmed and Sattar 2004, Nahar and Siriwardana 2009). However, for some groups of population, large degree of economic integration might be one of the sources of risk that cause and increase their vulnerable to poverty. As previously shown in chapters 3 and 4, in addition to adverse weather-related events, poor and vulnerable farm households in emerging market economies such as Thailand are substantially affected and feared by volatile and unforeseen market fluctuations in input and output prices. Soaring world market prices for major food crops and input especially rice, fuel and fertilizer in 2008 set the historical peak of food price crisis and the current international prices of food commodities have sharply increased again closer to this peak (UN 2009, FAO 2010).

The unexpected food price shocks have most affected consumers and producers especially in low-income food deficit countries in Asia and Africa (Ivanic and Martin 2008). Exogenous market fluctuations of agricultural commodity and input prices generate opportunities and risks to farm income. In this respect, farm households generally assume dual role of agricultural producer for market supply as well as consumer of self-produced agricultural output. As a producer, higher market prices for food crops mean higher revenue from sale of agricultural food production. As a consumer, the same increase in food prices leads to higher food expenditure for own consumption. Thus, while the increase in food price brings income gain for farm households with a food surplus, real income reduction and higher risk of falling into poverty is expected for food-deficit households (ASARECA 2008, von Braun 2008). However, price transmission differs between and within countries due to inefficient market mechanism and infrastructure such that high international price effects might not be fully translated to equivalent increases in farm gate prices (Cudjoe et al. 2008; Dawe 2008). Depending on relative

changes in prices of input and output, the decision on agricultural production and other income-generating activities is determined within household resource constraints.

In addition to price shocks, economic downturns such as recent global financial and economic crisis can affect non-agricultural activities of farm households when household members who are engaged in off-farm wage labor or non-farm self-employment are forced to migrate back to their rural place of origin (ADB 2009b) and to reduce the amount of remittances which they are sending to their family that lives in a rural area (Bresciani et al. 2002). As highlighted in chapter 4, particularly relevant in times of global climate change a more common concern of rural households is weather-related shocks which are argued to bring about an increased number and severity of extreme weather events such as flooding, droughts, storms and unusually heavy rainfall (Emanuel 2005, Trapp et al. 2007). Such weather calamities can be detrimental to household livelihood especially crop harvests, livestock health and asset damage (Asiimwe and Mpuga 2007, Pandey et al. 2007).

Analyzing the impact of external price shocks on the adjustment response of farm households and the resulting poverty needs to go beyond the limitation of positive (econometric) models. Several studies (Arndt et al. 2008, Dessus et al. 2008, Wodon et al. 2008, Zezza et al. 2008) applied simulation methods which are based on Deaton's approach (1987), and decomposition analysis (Valero-Gil 2008, World Bank 2008a). Such studies, which measure the aggregate effects of food prices on household well-being, e.g. by comparing rural versus urban consumers and producers, are useful especially for countries where poverty and food insecurity is widespread. However, these positive models are less relevant for emerging market economies such as Thailand where economic development and "pockets of poverty" coexist in large areas (e.g. the Northeast) and poverty is stochastic rather than chronic, i.e. households move in and out of poverty depending on external factors (Justino and Litchfield 2003). In addition, high correlation between input and output prices cannot be captured in positive models leading to overestimation of net income from food production (Heady and Fan 2008). In such models, the effects of price transmission are generally ignored and hypothetical homogenous prices are used instead of actual prices received and paid by farm households (Cudjoe et al. 2008, Ulimwengu et al. 2009). Possible allocation effects of price changes, e.g. intensification of higher-profitable crops at the expense of low-profitable crops or substitution of more expensive food consumption with cheaper food alternatives, are also often neglected which generates bias in impact estimation on poverty.

To overcome these limitations, a new analytical approach based on mathematical programming model can be a useful complementary tool to obtain an in-depth understanding of adjustment processes at the household level of typical rural households as a case study. As pointed out by

Brooks et al. (2008) farm household modeling is a suitable approach to assess micro-level impacts of exogenous conditions on household behavior such as their dual role as producer and consumer of food. Interactions between resource endowments and constraints on the one hand and activities concerning production, on-farm and off-farm labor allocation, and consumption of home-produced as well as purchased goods on the other hand can be taken into account (Taylor and Adelman 2003). In this regard, the concept of "typical farm[34]" analysis, which aims to illustrate the agricultural production systems and the decision making behavior of rural "benchmark" farm households, is incorporated in the mathematical programming approach. As opposed to large sample size required by positive econometric models, small sample size in a concentrated geographical area is sufficient for the typical farm approach ensuring the heterogeneity of socio-economic and natural frame conditions to a manageable level. The flexibility of constructing typical households provides a direct way to calculate individual vulnerability measures for subsets of household types. Hence, the new method based on mathematical programming and typical farm approach can be a good tool to assess individual household vulnerability for smaller geographical units and can thus be useful for a more refined targeting of poverty reduction and social protection policies.

This chapter aims to assess the impact of the global food and input price shocks in 2008 on vulnerability to poverty of a type of rural farm households in Northeast Thailand (specific research objective (III)). Taking into account major weather-related risks which are most relevant for agricultural production, the analysis focuses on farm households that are particularly at risk to fall into poverty with typical production and income portfolio identified in Ubon Ratchathani province. In particular, a risk-integrated mathematical programming model is proposed as an alternative to positive methods which have limitations regarding poverty impact assessment of shocks. By means of typical farm household modeling, individual household vulnerability, i.e. the probability to fall into poverty, can be directly evaluated to assist targeting of social protection policy measures.

[34] A typical farm is farm households being indicative for a substantial share of the farm household population with typical production and consumption characteristics for the conditions of the rural households in a defined region. (see Chapter 2.3.2)

The objectives of this chapter therefore are:

(i) To develop and test new methodologies to measure vulnerability to poverty of a specific household type with typical production and income portfolio identified in Ubon Ratchathani province,

(ii) To assess the ability of poor and vulnerable Thai rural farm households to respond to the price shocks,

(iii) To analyze the impact of the price shocks in 2008 on Thai rural farm households and the resulting vulnerability to poverty taking into account other multiple risks.

The chapter is organized as followed. Section 5.2 describes the theoretical framework of the farm household-level analysis in the context of vulnerability to poverty. Section 5.3 explains the methodology applied for obtaining a mathematical programming-based vulnerability estimate. Section 5.4 describes data collection and identification of typical farm household in the study area. Section 5.5 gives a descriptive analysis of model farm household characteristics, the farming system, the price observations and underlies the resulting model assumptions. In section 5.6 the empirical results of the mathematical programming model with regards to optimal household activity portfolios and vulnerability levels across the different scenarios are presented. Lastly, section 5.7 summarizes and draws conclusion.

5.2 Farm household model and vulnerability to poverty

To analyze the effect of external price shocks on the response behavior of farm household, a comprehensive model is needed especially in the context of developing countries where markets often do not exist nor perfectly function due to high transaction costs. The analytical framework applied in this chapter is based on the neoclassical economic theories of farm household behavior in developing countries, all of which assume that farm household pursues the goal of objective function maximization within a set of constraints (Schultz 1964, Chayanov 1966, Rosenzweig 1980, Mendola 2005). In contrast to Partial Equilibrium Models (PEM) and Computable General Equilibrium (CGE) models which take on the aggregate effects within the agricultural sector or the national economy, farm household modeling focuses on micro-level impacts of exogenous conditions on household behavioral responses (Brooks et al. 2008). In this framework, farm households do not only concern to maximize profit from agricultural production but the dual character as enterprise and family requires that utility through consumption of all commodities (e.g. own-produced goods, purchased goods and leisure) is also maximized subject to full income constraint. As a producer (enterprise), the household seeks to maximize farm profits, including implicit profits from self-produced and self-consumed goods,

by choosing the optimal allocation of labor and other inputs subject to prices, resource endowments, financial and technological capacity. As a consumer (family), the household aims to maximize a discount future stream of utility derived from the allocation of income from farm profits and wage earnings to the consumption of both purchased and self-produced commodities and services. Therefore decisions concerning production, on-farm and off-farm labor allocation, and consumption of home-produced as well as purchased goods are inter-related. Farm household model takes into account this interrelation in the form of objective function optimization, e.g. utility or household income maximization from different farm and consumption activities, subject to a range of constraints and the solution represents all endogenous variables as functions of exogenous variables (Taylor and Adelman 2003).

Furthermore, farm household models recognize the inseparability of production and consumption and resolve the phenomenon of slow-moving or negative supply responses to food-price increases as well as the positive own-price elasticity of food demand in farm households. Increase in prices of food crops generally prompt households to intensify the production of that crop. The marketed surplus also tends to increase since the opportunity cost of consuming home-produced food has risen. As a result, household income increases due to higher profit from farm production which leads to higher demand for food. However, the household at the same time faces higher food price for consumption which may offset the positive income effect (Ivanic and Martin 2010). The net effect on consumption therefore depends on the household utility function and the magnitude of the profit effect.

Several studies found that higher on-farm consumption can significantly dampen and possibly even reverse a positive effect of a price increase on the supply of food to the market (e.g. Kuroda and Yotopoulos 1978, Singh et al. 1986). In the developing countries high transaction costs in output and input markets can adversely encourage subsistence over commercial production. As Dyer et al. (2006) pointed out, shadow prices that influence opportunity costs of subsistence producers are indirectly affected by prices in other markets especially those of input factors which they have direct interaction with such as labor and land. Furthermore, subsistence households may be more concerned about food security for home consumption than cash income from commercial sale of surplus and hence cautiously convert the resources towards the production of cash-crops. This reservation behavior is particularly relevant for households with few productive resources and limited substitutability between them. For example, land quality may vary and be suitable only for particular crops which imply high cost of land conversion to accommodate other crops. Limitation of household on-farm labor and lack of access to seasonal hired labor markets make the intensification of cash-crop production more difficult. Together with the dynamics of input factor markets, increases in input prices for major factors such as

fertilizer and fuel might counteract the increases in output prices of cash-crops as an increase in production requires intensification of input factors.

More importantly, due to various uncertainties, fluctuations and risks involved in production and social context, farm households are viewed to be risk averse in their decision-making by avoiding large risks to ensure the minimum level of subsistence (Lipton 1968). The assumption of risk-averse behavior among farm households has been vindicated by numerous empirical studies (e.g. Dillon and Scandizzo 1978, Binswanger 1980). This presumption generally reflects the behavior of rural farm households in Northeast Thailand whose primary concern is subsistence production and the assurance of minimum level of household income necessary for basic needs through refraining from making decisions entailed with larger stakes (Grisley and Kellog 1987). In particular, liquidity and risk constraints may limit small farm households' supply response to price changes and support diversification of less-risky activities with low economic returns. Apart from yield uncertainty due to weather-risk, farm households are subject to additional price risk in case the market turns unfavorable by the harvesting period or face the situation of supply overflow. Hence, households must carefully respond to the positive price shocks by taking into account the resource constraints, risk perspective and the interactions of other prices in the markets. As a result, the net effect of an increase in the market price of food crops does not necessarily lead to a prompt increase in the market supply.

By means of farm household modeling, optimization adjustments in production, consumption and resource allocation as a response to the price shocks taken into account multiple sources of risks can be explicitly observed. Moreover, the comparison of the resulting households' expected income and variance of income before and after the price shocks allows assessing the impact of price shocks on vulnerability to poverty. As described in chapter 1, the notion of *vulnerability as expected poverty* (e.g. Pritchett et al. 2000, Christiaensen and Subbarao 2001, Chaudhuri et al. 2002, Chaudhuri 2003) is a basis for the analysis throughout this thesis. Hence, in this chapter the probability to fall below a relevant income poverty line will be predicted for both scenarios before and after the price shocks.

5.3 Mathematical programming methodology

Most of the current literature that has empirically measured vulnerability, defined as expected poverty which is the probability that a household's future consumption or income will fall below the poverty line, has used econometric approaches often based on simple cross section data (e.g. Chaudhuri et al. 2002). An alternative approach proposed here is to use mathematical programming (MP) models based on the construct of typical rural households as described in section 2. MP combines a vector of decision variables, which reflect a set of income-generating activities of a typical rural household, such that an objective function is maximized subject to specified resource and behavioral constraints. The MP model allows to explicitly incorporate risk, and hereby the distribution of household income for optimal farm household portfolios under different scenarios can be derived. However, there are some limitations of a mathematical programming model applied to poverty analysis. First such models have the tendency to generate optimal portfolios with overspecialization since not all real world constraints can be captured. Secondly transaction and information costs as well as the spatial dimension are ignored. Such weaknesses can be overcome by developing a multi-agent model using a cellular automata (CA) framework. In agriculture the use of such models were pioneered by Balmann (1997). While multi–agent models are a useful advancement of sector level mathematical programming, especially for predicting diffusion of innovations or assessing the consequences of changes in natural resource use for example, they are less appropriate for assessing the impact of exogenous price changes on poverty for specific type of households. Hence mathematical programming models representing certain household types can be a practical alternative to more complex econometric household models that require rigid assumptions on own- and cross price elasticities.

To apply such mathematical programming for poverty analysis of rural households in developing countries requires to adequately reflecting the utility functions of the poor. Risk-averse behavior is an important component of the household's decision making process adequately reflecting the conditions of people vulnerable to poverty. To reflect the general socioeconomic conditions of poor households in the respective provinces risk-averse behavior is assumed such that a typical farm household seeks to maximize household income subject to achieving a minimum level of income determined by basic consumption needs. Various techniques for incorporating risk-averse behavior into mathematical programming models are available, with quadratic programming (Markowitz 1952, Freund 1956) and linear approximation approaches such as Minimization of Total Absolute Deviations (MOTAD) (Hazell 1971) being the most commonly used ones. Alternative techniques are safety-first models, mean-standard deviation models, game theory models, and models which capture risk in the

constraint set such as discrete stochastic and chance-constrained programming (Hazell and Norton 1986). In this study Tauer's (1983) "Target MOTAD" approach is used whereby the deviation from a defined minimum level of income (e.g. poverty line) is minimized subject to the household's degree of risk aversion (McCarl and Spreen 2007).

The Target MOTAD model can be specified as follows:

$$\max \sum_j \overline{c_j} X_j \qquad \text{-- (1)}$$

such that:

$$Y_0 - \sum_j c_{jt} X_j - Z_t^- \leq 0, \quad for\ all\ t \qquad \text{-- (2)}$$

$$\sum_t p_t Z_t^- \leq \lambda \qquad \text{-- (3)}$$

$$\sum_j a_{ij} X_j \leq b_i, \qquad for\ all\ i \qquad \text{-- (4)}$$

$$X_j, Z_t^- \geq 0, \qquad for\ all\ j,t \qquad \text{-- (5)}$$

where $\overline{c_j}$ is the expected mean gross margin per unit of the j^{th} household activity across all states of shock occurrence, X_j is the level of the j^{th} household activity, Y_0 is the target income to be achieved (e.g. the minimum required income for the farm household to survive), c_{jt} is the expected gross margin per unit of the j^{th} activity in the t^{th} state of shock occurrence, Z_t^- is the negative income deviation from the expected mean gross margin in the t^{th} state of shock occurrence, p_t is the probability of occurrence of state of shock occurrence t, λ is the maximum average shortfall of income which still enables a satisfactory level of compliance with the target income, a_{ij} is the technical coefficient of the i^{th} resource required to achieve X_j, and b_i is the resource constraint level of i^{th} resource (McCarl and Spreen 2007). By parameterizing λ, a set of efficient farm plans with the maximum possible value of household income for any specified level of compliance with the target income is obtained. Households with the highest risk aversion may choose the farm plan related to the smallest possible level of compliance with the target income. Less risk-averse farm households might prefer farm plans promising higher levels of expected income but also higher levels of compliance with the target income providing that the absolute level of compliance with the target income remains sufficiently small.

The Target MOTAD model developed here represents a one-year time period and includes the main income-generating activities of households defined as typical for location-specific

conditions in Northeast Thailand as specified in chapter 2. Resource and consumption constraints and the seasonality restrictions of farming activities were incorporated in the model. Shock events were considered by identifying the most relevant weather-related shocks e.g. drought and flooding of agricultural land. The shock events are specified by time of occurrence, effect on crops and corresponding yield loss. Corresponding crop gross margins were quantified and the subjective probability of occurrence of each shock type was determined based on the expectations of the surveyed households. Thereby two different sets of prices were used. One consisting of farm gate and market prices for crops and inputs in 2007 (all converted to PPP$ in 2005), representing the situation before the price hike. And a second one consisting of farm gate and market prices for crops and inputs in 2008 (all converted to PPP$ in 2005), representing the situation during the price hike. This information was then used to construct the set of possible states of shock occurrence (see section 5.4 for gross margins and probabilities of different states of weather shock occurrence for 2007 and 2008 prices). Other risks were incorporated in the model as a probability for each state of shock occurrence assuming zero correlation among the individual shock events. The expected gross margin of each cropping activity is the mean gross margin per hectare over all possible states of shock occurrence. The deviations from mean gross margin in each state of shock occurrence were calculated, and applied in the Target MOTAD model to approximate the standard deviations of gross margins for each activity.

Solving the two Target MOTAD model[35] scenarios yielded the optimal activity portfolio of the farm household, corresponding expected mean and variance of total household income, for the situation before and after the food and input price crisis reflecting the conditions in the years 2007 and 2008. Results can be presented as a cumulative distribution function (CDF) of total household income which can be compared to the poverty line and thus allow deriving the probability of a typical household to be poor in some future period. The CDF of total household income can be formally written as:

$$F(x) = P(i \leq x) \qquad \text{-- (6)}$$

where i is a random variable of the discrete type, representing total household income, with probability density function

$$f(x) = P(i = x), x \in \Re \qquad \text{-- (7)}$$

The value of the CDF at each level x of total household income i indicates the probability that total household income is smaller than or equal to x. If $x = PL$ and PL is specified as the poverty line, then the value of the CDF at PL gives the probability of the household to be poor. Following the concept of vulnerability as expected poverty (Christiansen and Subbarao 2001,

35 The *General Algebraic Modelling System* (*GAMS*) was used to run the model.

Chaudhuri et al. 2002) and assuming that i is constructed based on another standard normal random variable, the expected mean of total household income, and the expected variance of total household income, this gives the vulnerability V_t of the household at time t, which can be formally specified as:

$$V_t = P(i_{t+1} \leq PL) \quad \text{-- (8)}$$

where i_{t+1} is the household's level of income at time $t+1$, and PL is the income poverty line. The impact of price changes between 2007 and 2008 on household vulnerability to poverty can be seen by plotting the CDF of each year.

5.4 Model framework

Based on household data from in-depth panel survey in 2007 and 2008 as described in chapter 2, the basic parameters of focused typical farm household group 2 ("agricultural" income poor and vulnerable with cropping and livestock farming system) are summarized in Table 5.1. These characteristics consist of monthly income per capita in PPP$, household size, agricultural labor ratio, labor capacity, land endowment, annual consumption requirements and shock incidences experienced between 2002 and 2008. All of these descriptive statistics are used as core model assumptions except the shock experience which is used as background information to derive endogenous risk parameters. The information in Table 5.1 is presented in median values, except for labor capacity which are imputed values and shock experience which is average frequencies of each shock type per household.

A typical farm household in Northeast Thailand is generally a small-farm holder consisting of 5 members. About half of its income-generating members working outside agriculture with an "agricultural member ratio", i.e. the proportion of household members engaged in own-farm agriculture to the household size, of 56%. The moderate ratio reflects the common practice of (seasonal) off-farm and non-farm self-employment among rural households in Northeast Thailand. Compared to the annual provincial poverty line of PPP$4411.65[36], they are income poor with monthly per capita income of PPP$67.20. The minimum annual target income for the model households are set equal to the regional poverty line. In order to represent a realistic household composition, the model household is assumed to comprise of 1 male adult, 1 female adult spouse, 1 adolescent member, 1 child and 1 elder. The annual labor capacity is derived from the assumption that each household member is unable to work everyday due to weather restrictions, social obligation, illnesses, housework activities, school time and leisure

[36] NSO and NESDB (2007)

requirement that affect each member on a different scale[37]. The model accounts for the fact that the adolescent and elder members are light labor performing physically less-demanding farm activities (e.g. weeding and harvesting) whereas the adult members have the physical capability to engage in physical-intensive hard labor activities (e.g. plowing and transplanting). While hard labor may replace light labor for on-farm activity, light labor can be substituted by seasonally available off-farm employment.

Household owns a total land area of 4.26 ha of which 84% is allocated for cultivation of major crops (jasmine rice, glutinous rice and cassava). The remaining land area is allocated for housing and livestock stall. The annual household requirement of glutinous rice, which is the major staple food for Northeastern culture, equals to 1122.5 kg, half of which consists of own-consumption for household members (the figure is comparable with the finding of Isvilanonda and Kongrith 2008), 30% is reserved for visitor-consumption such as friends, neighbors, relatives and guests during celebrations and 20% is reserved as a buffer stock in case of crop failure due to frequent drought and flooding of agricultural land. The household's required annual consumption of purchased non-rice goods are defined at PPP$607.70. In addition, the model household frequently suffers from covariate weather shocks of drought and flooding as well as idiosyncratic shocks of illness and death of household members.

[37] (i) Annual hard labor capacity = 216 person days (male adult member) + 144 person days (female adult spouse) = 360 person days. (ii) Monthly light labor capacity during school time (January-March, June-September) = 8 person days (male adult member) + 12 person days (female adult spouse) + 10 person days (adolescent member) + 5 person days (child) + 10 person days (elder member) = 45 person days. (iii) Monthly light labor capacity during school break (April-May, October-December) = 8 person days (male adult member) + 12 person days (female adult spouse) + 20 person days (adolescent member) + 10 person days (child) + 10 person days (elder member) = 60 person days.

Table 5.1: Typical farm household characteristics

Characteristics	Unit	
Monthly per capita income	PPP$	67.19
Minimum annual household target income[1]	PPP$	4411.65
Household size	persons	5
Agricultural member ratio	%	56.5
Annual family labor capacity		
Hard labor	person days	360
Light labor	person days	615
Land endowment		
Total land	ha	4.26
Crop land	ha	3.58
Annual consumption requirement		
Jasmine rice	kg	0
Glutinous rice	kg	1122.5
Vegetable	kg	234.4
Cassava	ka	0
Non-rice purchased consumption	PPP$	607.7
Shock incidences (2002-2008)		
All shocks	number	4.2
Drought	number	0.7
Flooding	number	1
Crop pests	number	0.4
Illness of household member	number	0.7
Death of household member	number	0.2

[1] Annual target household income is set equal to provincial poverty line.
Source: DFGFR756 survey (2007) and (2008) and in-depth survey Ubon Ratchathani province.

Table 5.2 shows major crop portfolios and production technologies that form the technical coefficients in the model. The major crop portfolios of the typical model farm household include jasmine rice, glutinous rice, vegetables and cassava. Yield levels of the model household for jasmine and glutinous rice are slightly lower than provincial average of 1971.25 kg/ha (OAE 2010). Although both rice varieties are cultivated once a year and have similar production process, market price premium of jasmine rice is substantially higher than those of glutinous rice which is more preferred by the Northeastern farm households for subsistence consumption. To ensure food security, households reserve necessary amount of glutinous rice yield for subsistence consumption while jasmine rice yield is mainly sold for cash income. Vegetable such as chilli, cabbage, and spring onions are generally grown in the small backyard of the residential area for home consumption in multiple cycles throughout the year. Therefore the vegetable yield figure is an aggregation of several vegetable types and harvesting cycles over one year period. Lastly, cassava is cultivated once a year not for consumption but for sale to industrial processing. In practice, the complete substitution between jasmine and glutinous rice is feasible. However, the location, topography and land quality differences impose higher cost of substitution between rice and cassava while backyard plot is generally reserved for home vegetable. Apart from field

crops, households undertake livestock farming such as buffalo and cattle for sale as well as chicken for consumption. A by-product from buffalo and cattle is manure which can be used as additional fertilizers and substitute for chemical fertilizer[38]. Pure chicken manure, on the other hand, is not widely used since farm households prefer processed organic fertilizer derived from chicken manure and compost purchased on the market.

Table 5.2: Production technology and input intensity of major crops (per hectare per year)

	Crop type			
	Jasmine rice	**Glutinous rice**	**Vegetable**	**Cassava**
Yield (kg)	**1958**	**1527**	**1600[a]**	**6250**
Input use				
Seeds (kg)[b]	66	37.5	10	4890.5
Fertilizer (kg)				
Chemical	95	123.6	-	250
Organic	178.8	276.9	50	468.8
Animal manure	245	491	313	-
Fuel (liter)	15.6	15.4	-	20.3
Family Labor (person days)				
Hard labor	24.5	26.5	87.5	3.1
Light labor	67	69.6	212.9	99.6

[a] Vegetable yield is an aggregation of several vegetable types and harvesting cycles over one year period.
[b] Unit of seeds for cassava is piece.
Source: In-depth survey Ubon Ratchathani province.

The types and amounts of input typically used are an important determinant of the effect that input price fluctuations can have on household net crop income. With all crops sharing common input, input intensity is generally low but a relatively large proportion of external inputs (e.g. chemical fertilizers and fuel) are used. Despite widespread mechanization to facilitate some part of on-farm work (e.g. plowing), production processes (e.g. weeding and harvesting) are dependent on household labor with vegetable as the most labor intensive crop.

In Thailand, jasmine and glutinous rice usually have the same cultivation period between May and November while cassava cultivation usually begins in April and harvested in January. The process of rice and cassava cultivation comprises of a few standard practices such as plowing, seeding or transplanting, fertilizing and harvesting, each of which is carried out in a short time and requires a only few care-taking throughout the cropping cycle. In this region, application of pesticide and herbicide is rare and seeds are taken from own-yield reservation whose costs are negligible. Fuel for machine plowing, chemical fertilizers, organic fertilizers (e.g. chicken manure and compost) and animal manure (i.e. by-product from buffalo and cattle husbandry) are the major input factors for rice. For cassava, similar major input except manure is required but with relatively less labors intensity and more fertilizer. Cost of machine rent is assumed out since

[38] The substitution ratio between manure and chemical fertilizer is assumed at 4:1 kg.

almost every farm household owns a plowing machine. Vegetable production for home consumption, however, only applies organic fertilizer, manure and basic gardening tools. The model household is assumed to repeat vegetable production cycle for every 3 months but harvesting is feasible for daily consumption. The household primarily relies on family labor for all on-farm activity except for harvesting when they occasionally receive support from additional exchange labor from neighbors and friends at no charge instead of costly hired labor. In each month, excess family labor from on-farm activity is transferred to off-farm and non-farm employment except during peak-period where most of family labor is allocated to major on-farm activity (e.g. plowing, seeding and harvesting).

Figure 5.1 shows the changes in prices for input factors and products between 2007 and 2008 as observed from the additional in-depth data collection among 64 households in Ubon Ratchathani and official statistical data. Assuming similar market integration across all households in the study area, the complete dataset of typical farms has been used in order to overcome a potential bias that could be generated if using the relatively small number of households which form the model households. Over a one-year period, wholesale market price of jasmine rice in Thailand had increased by 38% which is transferred to 30% increase in farmgate price[39]. From this point of view one may presume that the benefit of the global price increase had almost fully trickled down to jasmine rice farmers. While cassava experienced a slight farmgate price decrease of almost 15%, wholesale price had increased by 20%. At the same time, price of fuel, chemical and organic fertilizer had increased by 43%, 31% and 13%, respectively. The net effect of price change is thus ambiguous depends on the relative prices perceived by farm households at the time when farm planning and input decisions are made.

[39] Monthly development of wholesale market rice prices in Thailand is provided in the Appendix C.

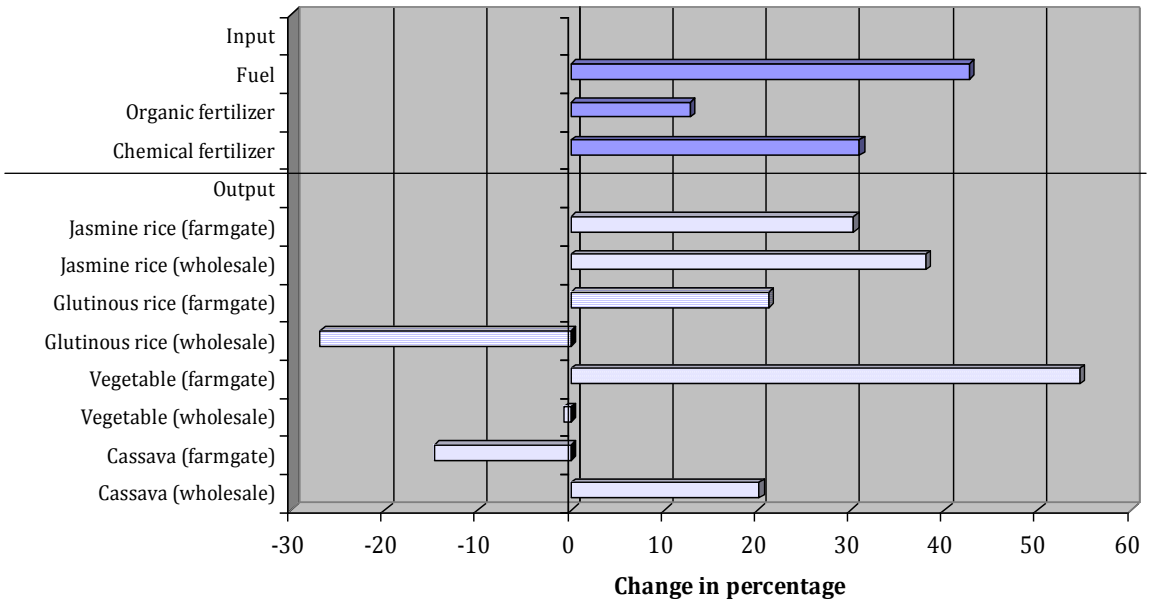

Figure 5.1: Price changes of output and input 2007-2008 (percentage)

Note: All units are "per kilogram" except for fuel is the unit "per liter".
Source: (i) Farmgate prices: In-depth survey Ubon Ratchathani province (n = 64); (ii) Wholesale prices: Office of Agricultural Economics and Department of Internal Trade.

Table 5.3 presents the annual gross margins per hectare of each crop under different states of weather-related shocks for the 2007 and the 2008 prices. As identified in the previous findings, flooding and drought are the most relevant shock types. Hence four weather-related shock scenarios are considered: (i) no shock, (ii) flooding, (iii) drought and (iv) both shocks, with different degrees of yield reduction and subjective probability of occurrence assigned for each scenario. In this analysis, gross margin is defined as cash income from market sale and the imputed value of self-consumption of home-grown food crops, both based on farmgate prices. Under current productivity, gross margins are generally highest for vegetable followed by jasmine rice, glutinous rice and cassava in both years. Despite increase in input prices in 2008, the positive price effect from the output side brings about a substantial increase in gross margin of vegetable (56%), jasmine rice (32%) and glutinous rice (15%). Only cassava had a negative gross margin in 2008 representing 65% reduction compared to 2007 due to a considerable drop in farmgate price and intensive purchased input use. Results further show that weather-related shocks can lead to negative gross margins and the changes in relative prices from 2007 to 2008 generally augmented such losses.

Table 5.3: Gross margins across states of weather-related shocks

(a) 2007 prices

		Gross margin per hectare per year (PPP$)				
Scenario	Yield reduction (%)	Jasmine rice	Glutinous rice	Vegetable	Cassava	Probability of occurrence
No shock	-	855.8	484.3	776.9	584.1	0.43
Drought	81	25.5	-91.3	136.1	-225.7	0.21
Flooding of agricultural land	65	185.2	19.4	259.4	-70.0	0.24
Both shocks	97	-137.0	-203.9	10.8	-384.2	0.12
Expected value		400.2	168.5	425.3	139.8	
Variance		32220.6	12312.3	23422.3	20801.5	
Standard deviation		179.5	111.0	153.0	81.6	

(b) 2008 prices

		Gross margin per hectare per year (PPP$)				
Scenario	Yield reduction (%)	Jasmine rice	Glutinous rice	Vegetable	Cassava	Probability of occurrence
No shock	-	1121.0	576.7	1206.5	329.8	0.43
Drought	81	39.0	-120.6	216.5	-360.9	0.21
Flooding of agricultural land	65	247.1	13.5	406.9	-228.0	0.24
Both shocks	97	-172.7	-257.0	22.7	-496.0	0.12
Expected value		527.4	194.1	663.3	-49.1	
Variance		55043.2	17739.5	56284.8	10572.3	
Standard deviation		234.6	133.2	237.2	67.4	

Sourec: In-depth survey Ubon Ratchathani province.

As mentioned in the previous sections, a distinct quality of Target MOTAD approach in the mathematical programming model is the assumption of risk-averse behavior of the model household. Figure 5.2 presents the individual risk coefficients of the households that underpin the representative households on which the models are based upon. The data in Figure 5.2 are derived from the respondents self-assessment of her attitude toward risk using a scale ranking from 0 (unwilling to take risk) to 10 (fully prepared to take risk). Results underline the assumption of risk-averse behavior as captured in the Target MOTAD model showing that the typical households are generally risk-averse but the degree of risk aversion varies while none of the households is completely risk averse or fully prepared to take risk. Similar risk-aversion pattern is found among 64 sub-sample and all 944 complete sample households in the province. This finding supports the application of the Target MOTAD model in order to capture risk-averse behavior in decision-making.

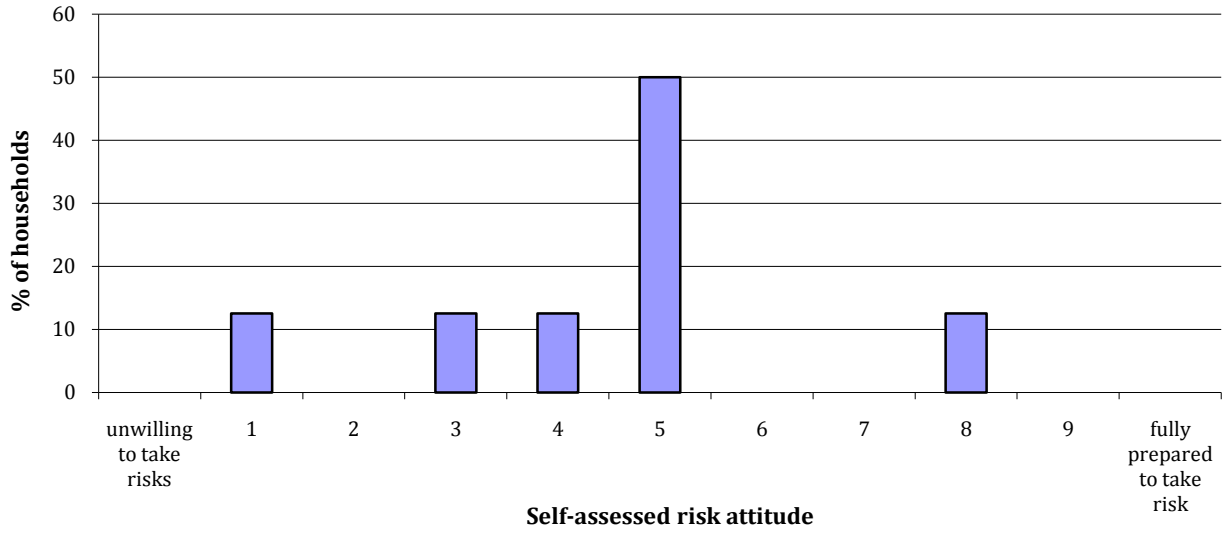

Figure 5.2: Self-assessment of risk attitude among typical farm households in Ubon Ratchathani province

Note: n=8. Self-assessment ranges from 0 (=unwilling to take risk) to 10 (fully prepared to take risk).
Source: DFGFOR756 survey (2008)

5.5 Results

Using the assumptions for the typical farm household described in the previous section, Target MOTAD models were solved to determine optimal adjustments of farm household activity with a decreasing degree of risk aversion (λ=0, 250 and 600). First, a base solution was found for the situation of the 2007 prices (see Table 5.4). Under regular market and weather conditions, varying the degree of risk aversion does not affect household resource allocation. Based on 2007 prices, under high level of risk-aversion (λ=0), the optimal production portfolio is slightly different than under lower risk-aversion degree (λ=250 and 600). Next, the model was recalculated with the situation of the 2008 prices. Table 5.4 shows the effect of the price shocks by comparing the expected household income, the standard deviation of income and optimal solutions of the typical household's resource allocation over the different income generating activities in 2007 and 2008 price scenario for different degrees of risk.

Table 5.4: Optimal farm household activity portfolios across price scenarios

	Activity level					
	2007 prices			2008 prices		
Activity	*λ=0*					
Jasmine rice (ha)	1.236	1.769	1.769	1.069	1.436	1.436
Glutinous rice (ha)	0.735	0.735	0.735	0.735	0.735	0.735
Vegetable (ha)	-	0.053	0.080	-	0.080	0.080
Cassava (ha)	0.501	1.074	1.076	0.334	0.700	0.700
Off-farm employment (person days)	605	482	473	638	542	542
Total farm household income (PPP$)						
Expected value	7118.1	7560.9	7568.6	6893.7	7298.3	7298.3
Variance	3081098.4	7786115.0	8169386.7	2907562.4	6056191.4	6056191.4
Standard deviation	1755.3	2790.4	2858.2	1705.2	2460.9	2460.9

Note: Inconsistencies are due to rounding errors.
λ=maximum shortfall from target-level allowed (risk-aversion degree).
Source: Own calculation.

The results show that lower degrees of risk aversion increase the cultivation area of jasmine rice, vegetable and cassava while glutinous rice area remains constant. In the 2007 baseline scenario under lower degree of risk aversion (λ= 600), larger rice land area is allocated to jasmine (1.77 ha) while glutinous rice is only cultivated to meet annual household consumption requirement (0.74 ha) and the remaining field crop land is allocated to cassava cultivation (1.08 ha). Vegetable cropping is restricted to residential backyard area (0.08 ha) for home consumption. Hence, jasmine rice, glutinous rice and cassava planted areas are maximizing field crop land capacity of 3.58 ha. Total household labor of 473 person days are allocated to off-farm employment.

Other things being equal in the 2007 baseline model setting, output and input prices were allowed to increase to 2008 level. Despite higher farmgate price of jasmine rice, the total output and input price shocks prompted the household to adjust by diversifying out of farming and reduce the area for cassava and jasmine rice, the two commercial crops. Cultivation area allocated to jasmine rice and cassava declined to 1.44 ha (-18.6%) and 0.7 ha (-38%) respectively. Glutinous rice and vegetable cultivation as subsistence crops remained unchanged. As a result of cropping portfolio adjustment, only 2.87 ha of field crop land is used. On the other hand, the optimal adjustment increased household labor allocation to off-farm employment to 542 person days (14.5%). On-farm household labour is shifted to off-farm employment as a result of lower gross margin from agriculture whereas off-farm wage income (held constant in the model as in the base scenario) became relatively more attractive to on-farm earnings. This allocation effect between crops as well as between on-farm and off-farm engagement was particularly strong at high degrees of risk aversion.

Simulation results suggest that typical farm households in Thailand as portrayed by the model did not benefit from the 2008 price hike. Compared to 2007 baseline, the price shocks lowered expected household income, income variance and standard deviation of income in 2008. Several reasons could be attributed to this observation. First, the immediate increase in input prices imposes cash constraints for the purchase of inputs during the farm planning and planting period. This finding is evident from the in-depth survey responses in the study area. Second, farm households were doubtful whether the unexpected price increase of output (especially jasmine rice) at the time of planting would persist until the time of harvest and hence were reluctant to promptly intensify the production. Third, the changes in the agricultural input and output prices relationship from 2007 to 2008 has decreased the marginal returns to labor in agriculture relative to non-farm wages. Fourth, the general uncertainty especially inflicted by input price shocks such as fuel and fertilizer augmented the tendency to opt for further off-farm opportunities. This seems plausible for the typical part time agricultural households which are now quite common for the lower potential agricultural areas in Northeast Thailand.

Figure 5.3 shows the effect of the 2008 price shocks on vulnerability to poverty. The cumulative distribution functions of household income across different states of weather-related shock occurrence show the probability of falling below the predefined level of minimum income (i.e. provincial poverty line). It becomes clear that the typical farm household in the model was already vulnerable to poverty prior to the 2008 price shock. It is also evident from Figure 5.3 that for some shock scenarios a considerable poverty gap has existed which became smaller after the food price shock. Compared with the 2007 baseline situation, although the increase in output and input prices has lowered household expected income, the income variance also decreased (see Table 5.4) leading to a reduction in the probability of falling below the provincial poverty line from 57% to 33%.

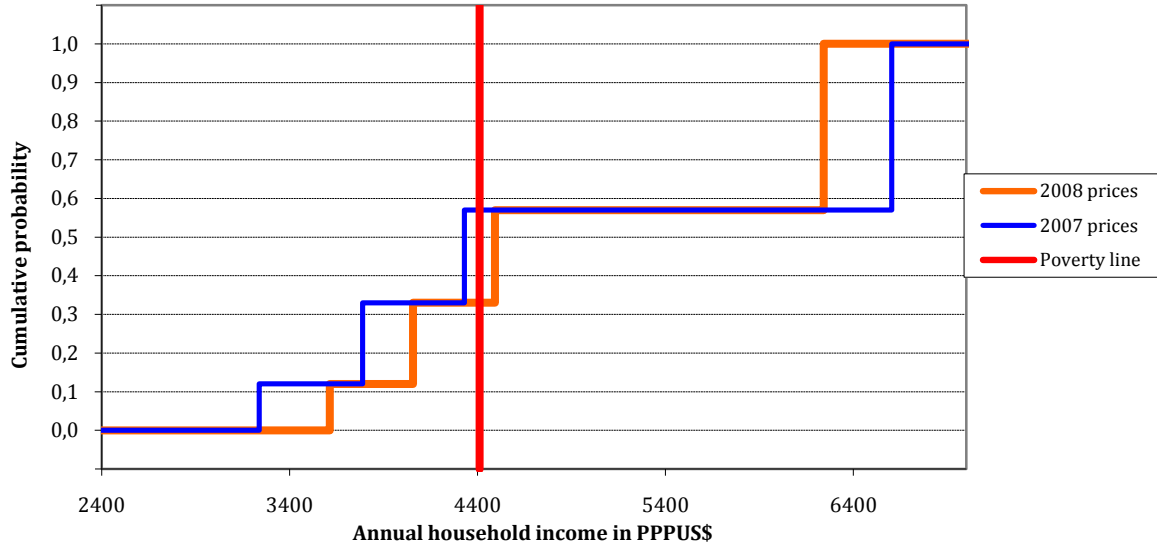

Figure 5.3: Discrete cumulative distribution functions of household income among and across price scenarios (Target deviation ≤ 600)

Source: Own calculation.

5.6 Summary and conclusion

In this chapter the impact of the 2008 global food and input price shocks on the vulnerability to poverty of poor rural farm households in Northeastern Thailand is assessed. For this purpose, three objectives are carried out: (i) to develop and test new methodologies to measure vulnerability to poverty of a specific household type with typical production and income portfolio identified in Ubon Ratchathani province, (ii) to assess the ability of poor and vulnerable Thai rural farm households to respond to the price shocks, and (iii) to analyze the impact of the price shocks in 2008 on Thai rural farm households and the resulting vulnerability to poverty taking into account other multiple risks. Based on mathematical programming and typical farm households approach, new methodology using Target MOTAD model is developed. The focused typical group of households in Northeast Thailand are eight rural farm households characterized by "agricultural income poor and vulnerable with cropping and livestock farming system" (see Chapter 2). The model constructed by additional data collected from in-depth survey in Ubon Ratchathani demonstrates optimization behavior of agricultural production in response to price increases facing endogenous risks, agricultural production pattern and household resource constraints.

With regards to the first objective it can be stated that mathematical programming models can be a useful tool to simultaneously consider different shocks such as economic and weather-related shocks, high correlation between output and input prices, as well as allocation effects of

the price shocks in a theoretically consistent framework. Furthermore, the incorporation of risk through the Target MOTAD approach is a plausible representation of the degree of risk aversion which is empirically evident among rural farm households in the study area. In addition, the flexibility of constructing a typical household model enables individual vulnerability measures to be directly assessed for subsets of household types. With this approach conclusions can be drawn for poverty reduction policies of smaller geographical units which would be difficult with the use of positive econometric methods due to the problem of small sample size.

With respect to the second objective, simulation results from 2007/2008 scenario comparison show that farm households responded to the price shocks by reducing on-farm activity while shifting more household labor towards off-farm employment. Economically optimal adjustment leads to a reduction in the cropping area for cassava and jasmine rice, the two commercial crops, while the glutinous rice and backyard vegetable cultivation remained unchanged for subsistence consumption. This is possibly due to cash constraints imposed by unexpected high cost of input purchase at the beginning of planting period and the uncertainty of falling output prices at the time of harvest. As anticipated production intensification requires greater variable input use, the increase in output price is largely offset by the increase in input prices especially in Thailand where farm households intensively use chemical fertilizer and machinery. Furthermore, under existing resource endowment and higher input prices, the increase in output price is not sufficient to bring about intensification of cash crop. This conclusion is supported by the indicative expression from the in-depth survey that the majority of farm households are unwilling to expand jasmine rice cultivation area due to lack of land and labor and the priority to secure glutinous rice area for consumption.

For the third objective, model results show that the typical farm households are vulnerable to poverty, having a 57% probability of being poor in a normal year, i.e. before the price shock. Given the price level in 2008, optimal adjustment leads to a reduction in the expected household income and the income variance reducing the probability to fall below the provincial poverty line to 33%. However, the reduction in vulnerability depends on the availability of off-farm employment opportunity. In comparison to the cross-section-based method of vulnerability computations (e.g. Chaudhuri et al. 2002) the calculated vulnerability measure is believed to be more situation-specific. Also the baseline solution of the mathematical model can be used as a benchmark for impact assessment of policy interventions or external shocks such as food price hikes analyzed here.

In conclusion this chapter on modeling the impact of the food price crisis using a case study approach provides a good starting point for further analysis when formulating different household systems (e.g. commercial-oriented farms, different locations with different natural

environments). The methodology can also be used to test the impact of policy interventions and the introduction of new technologies on vulnerability to poverty. It is important to note that the response to price shocks is primarily constrained to the availability of resources in order to expand the production of cash crop. This finding is in line with the economic theory that the supply price elasticity is lower in the short-run than in the long-run due to rigidity of input availability as outputs are not only influenced by prices, but also by production factors especially capital, labor and land which are fixed in the short term (e.g. Binswanger 1989). Furthermore, recognizing the household's objective of assuring food security over cash-income maximization, substitution between cash-crop and non-cash crops needs a substantial price incentive in addition to alternative secured food source.

Concerning policy implications for the Northeastern Thailand, this chapter discloses several possible constraints that rural farm households face in their agricultural production in the short-run. These include limited land and labor endowment with agricultural land as well as high dependency on mechanization and purchased-inputs especially chemical and organic fertilizers. As a response to agricultural production contraction, alternative options to generate income such as engagement in off-farm wage labor and non-farm self-employment provide an effective transitory shock-coping strategy. Further investigation is needed here in order to better understanding the exact nature and underlying causes of such entry-barriers to effective risk management and shock coping in order to guide possible policy interventions which can help to overcome such impediments to efficient risk-mitigation behavior.

Chapter 6

Synthesis

This thesis was conducted within the research project on "Impact of Shocks on the Vulnerability to Poverty: Consequences for Development of Emerging Southeast Asian Economies" (DFGFOR756) covering six provinces in Thailand and Vietnam. The objective of the thesis is to analyze the phenomena of vulnerability to poverty among agricultural-dependent households in three provinces in Northeast Thailand. This includes assessing the types and the impact of shocks and risks faced by rural farm households and their *ex-post* shock coping as well as *ex-ante* risk mitigation strategies. The thesis is presented, after the introduction (chapter 1) and data collection and general descriptive results (chapter 2), as a series of three individual papers which are described in chapters 3, 4 and 5. This chapter summarizes key findings obtained from the analyses conducted in the three major studies as presented in chapters 3-5, draws overall conclusions and elicits recommendations for policy and future research.

The analyses presented in this thesis draw on a comprehensive household database generated from two complementary household surveys: two-period base panel survey and two-period in-depth panel survey. The base panel survey was conducted in April-May 2007 and followed-up in April-May 2008 among a total of about 2,200 representative households identified by the 3-stage stratified cluster sampling approach in Ubon Ratchathani, Buriram and Nakhon Phanom provinces in Thailand. Complementary data was collected in an in-depth panel survey conducted in May-June 2008 and January 2009 among a sub-sample of 64 households drawn from the original pool of households in Ubon Ratchathani province. The purpose of additional data collection was to establish in more details the agricultural technology conditions and identify constraints of the farm households which are typical for farming in Northeast Thailand. Following a two-step identification approach, the selected households fulfill the criterion of agricultural and vulnerability to poverty aspects and represent 8 different groups of typical farms. In this study, 8 typical farm households corresponding to the group "agricultural income poor and vulnerable farm households with dual agricultural production systems of cropping and livestock" are chosen as an example case to specifically analyze their decision-making behavior using farm household modeling.

6.1 Summary of key findings

Following key findings can be summarized based on the results presented in the three chapters correspond to the specific research objectives defined in chapter 1.

(I) The first specific research objective was addressed in chapter 3 entitled "Shocks and *ex-post* coping strategies of rural households": *to identify and classify types and effects of shocks and to analyze ex-post coping behavior of the households in three provinces in Northeast Thailand: Buriram, Ubon Ratchathani and Nakhon Phanom.*

In chapter 3, a comparative static analysis of the two-period panel surveys shows a consistent pattern of shock-coping situations in the study area. A large number of rural households most frequently suffered from weather-related agricultural shocks especially drought and flooding, followed by health shocks (e.g. illness and death of household members), economic shocks (e.g. price fluctuations, job loss and business collapse), and social shocks (e.g. social obligation expenses). However, the majority of shock-affected households did not take any *ex-post* coping action. Most remarkably, in case of coping, households are more likely to take a coping measure to deal with health-related events as compared to other shock types. However, the current situation reveals that households are usually left alone to deal with shocks using their own available resources and the public supports are rarely used. Furthermore, reported shock types correlate with the level of well-being of the households as measured in income and asset: poorer households are found to be more susceptible to health shocks while wealthier households are more prone to economic and social shocks.

Results show that the probability to cope increases with the number of migrant numbers and income and asset loss, especially such loss due to health shocks. On the contrary, households' wealth status and engagement in agriculture as well as further distance to market are negatively correlated to the coping action probability. For all shock types, borrowing was found to be the major *ex-post* coping measure especially among lower-income households while households with higher income prefer using savings and selling assets. Additionally, self-insurance measures such as reallocation of household resources play a prominent role to deal with agricultural shocks, especially among households with higher education level. However, no conclusion can be made about the role of private remittances and public transfers because the coefficients in the probit models are not consistent between the two periods.

(II) The second specific research objective was addressed in chapter 4 entitled "Weather risk perception and *ex-ante* mitigation strategies of rural households": *to assess the relationship between weather-related shock experience and subjective perception of future weather risks as well as its influence on the application of ex-ante risk mitigation strategies of rural households in Northeast Thailand and Central Vietnam.*

Chapter 4 provided preliminary yet important insights into the relationship between shock experience, subjective risk perception formation and its influence on *ex-ante* risk management strategies with regards to weather risk among rural households. The analysis offers a cross-country comparison in three provinces in Northeast Thailand (Buriram, Ubon Ratchathani and Nakhon Phanom) and three provinces in Central Vietnam (Dak Lak, Ha Tinh and Thua Thien Hue). Results indicated that households in both countries are affected by different types of shocks among which adverse weather events (especially drought, flooding and heavy rainfall) rank highest followed by socio-demographic shocks (mainly illness of household members). While a large share of households in Thailand experienced economic shocks especially price fluctuations of production inputs and outputs, Vietnamese households are more prone to biological shocks, such as crop pests and livestock diseases. In particular, the outcome of the analysis in both countries shows that poor households (income below poverty line) are exposed to weather and economic shocks substantially more than the non-poor (income above poverty line). Furthermore, pessimism with regards to subjective perception of respective future risk is observed through a large discrepancy between shock experience and risk expectation in terms of share of households expecting future risk and the anticipated frequency and severity of risk, especially among poor households. In both countries the expected frequency and severity of risks is highest for weather events. However, despite vast anticipation of weather risk, only a small fraction of Thai and Vietnamese households applied respective precautionary measures. On average, poor households apply *ex-ante* mitigation action more often than non-poor households in Vietnam whereas the opposite relationship is found in Thailand.

Results confirmed that past weather shock experiences positively influence the formulation of subjective weather risk perception, which further has a positive influence on the decision to use *ex-ante* weather risk mitigation strategies. In particular, results show that higher degree of subjective weather risk perception of households is substantially shaped by the experience of weather shocks, poverty status (below income poverty line), agricultural occupation, membership in socio-political organization and age of the respondent as well as location factors. More importantly, the degree of subjective weather risk perception was shown to positively influence the application of *ex-ante* weather risk management strategies. On the other hand, the probability of *ex-ante* weather risk mitigation decreases with increasing income level of Thai households whereas location factors, ethnicity and off-farm employment are important mitigation determinants for Vietnamese households. The probability to apply *ex-ante* risk preventive measures is significantly lower for households living in Dak Lak province than in the province Ha Tinh. Households that belong to ethnic Kinh majority are more likely to apply risk prevention than the ethnic minority. In contrast higher degree of income source diversification through off-farm employment decreases the likelihood that *ex-ante* weather risk management is

applied. Further results identified the likelihood to engage in collective action diversification to increase with rising subjective weather risk perception in both countries. In Thailand, similar significant positive influence of weather risk perception is found for income portfolio adjustment while no such link is found with regards to the decision to invest and accumulate savings. Income level and the degree of agricultural engagement are further identified as significant determinants of investment activity while savings accumulation is significantly influenced by poverty status, engagement in agriculture and off-farm employment of household members. In Vietnam, asset values, land size and location factors stand out as the most important factors for collective action and investment activity.

(III) The third specific objective was addressed in chapter 5 entitled "Impact of price shocks on farm household vulnerability to poverty": *to assess the impact of the global food and input price shocks in 2008 on the adjustment decisions and the resulting vulnerability to poverty of rural farm households in Northeast Thailand by developing a new approach based on mathematical programming model of typical farm households identified in Ubon Ratchathani province.*

In chapter 5, the impact of the 2008 global food and input price shocks on the vulnerability to poverty of a specific household type was assessed using a mathematical programming model approach. The focused typical group of households in Northeast Thailand is represented by a sub-sample of 8 rural farm households purposively selected in Ubon Ratchathani province characterized by "agricultural income poor and vulnerable with cropping and livestock farming system". To demonstrate optimization behavior of agricultural production in response to price increases facing endogenous weather-related risks, agricultural production pattern, household resource constraints and risk-aversion behavior of model farm households, a Target MOTAD mathematical programming model was developed. The approach allows incorporation of economic and weather shocks, high correlation between output and input prices, as well as allocation effects of the price shocks in a theoretically consistent framework and enables direct observation of behavioral adjustment when the underlying condition is modified.

Simulation results reveal that household cannot profit from the output price increase due to the simultaneous rising of input price that crowds out the positive price effect. As a result, Thai farm households responded to the price shocks by reducing on-farm activity while shifting more household labor toward off-farm employment. Due to cash constraints imposed by unexpected high cost of input and the uncertainty of price fluctuation, economically optimal adjustment leads to a reduction in the cropping area for cassava and jasmine rice, the two commercial crops, while the glutinous rice and backyard vegetable cultivation remained unchanged for subsistence consumption. Results imply that the increase in output price is largely offset by the increase in

input prices especially in Thailand where farm households intensively use chemical fertilizer and machinery. Furthermore, model results show that the typical farm households are vulnerable to poverty, having a 57% probability of being poor before the price shock. Given the price level in 2008, optimal adjustment leads to a reduction in the expected household income and the income variance which reduces the probability to fall below the provincial poverty line to 33%. However, the reduction in vulnerability depends on the availability of off-farm employment opportunity.

6.2 Conclusions and recommendations

In emerging market economies such as Thailand, rural farm households are threatened by poverty and vulnerability due to constant confrontation with various shocks and risks. Recognizing the impact of negative stochastic events on household income and well-being, poverty reduction strategies should take into account not only the needs of currently poor rural farm households but also of those at risk to be poor in the future. Although adverse events such as weather calamity or market fluctuations can not be fully prevented but their effects can be moderated through a combination of effective *ex-post* shock-coping actions and *ex-ante* risk mitigation strategies. In this regard, a great importance is placed on social risk management that recognizes different preparation and intervention instruments to tackle specific types of events for specific types of households.

This study highlights the fact that the majority of rural farm households are mostly frequently and severely faced and feared by weather adversities especially among poor farm households. In particular, flooding and drought are annually anticipated and have a critical implication on the agricultural production and household income. Although the analyses had shown that experience with weather shocks shapes subjective weather risk perception and increases the likelihood to apply *ex-ante* weather risk prevention, the current situation reveals that mitigation action is rarely applied *ex-post* as well as *ex-ante* to cope with and prevent losses from weather-related agricultural shocks. This points out the need to investigate the entry-barrier to effective shock-coping and risk-prevention mechanism perceived as feasible and available by the households. For those who cope with shocks *ex-post*, existing public supports such as social relief for natural disasters are barely taken. The reason could be long bureaucratic process as well as limited financial and technical capacity of local public institutions to provide adequate support to compensate for income and asset losses caused by frequent flooding and drought. As a result, households need to rely on their own available resources to overcome the hardship. While households with higher income have a possibility to draw on savings and sell assets, lower-income households primarily depend on borrowing, thereby accentuating the vicious

cycle to get out of poverty. Hence, to strengthen individual household *ex-post* coping capacity, it is necessary for policy makers to extend the scope and intensity of public support scheme to especially attend to the poor not only by giving the relief transfers in the short-run but also giving assistance in building savings and assets, favorable credit borrowing conditions and create off-farm employment opportunity in the long-run. In addition, public efforts can be fostered to promote weather insurance scheme alongside existing crop price guarantee to accommodate poor farm households to cope with weather adversities (Jitsuchon 2010).

To assist *ex-ante* weather risk management, public authorities should integrate local experiences in making public forecasts and listen to the voices of the poor to design appropriate preventive measures against weather risks. Findings in Thailand and Vietnam show the importance of collective action as the most frequently applied *ex-ante* weather risk mitigation measure. Communication of weather risk awareness should therefore be accompanied by strengthening community capacity and enhancing inter-household cooperation to jointly prepare for weather risks. At the same time, individual preventive measures such as investment in the security of homestead and agricultural land should be supported, for example, through provision of durable construction materials by village budget funds and labor assistance among households. More importantly, community support should focus on households in lower-income group as they are mostly affected by past weather shocks and feared by future weather risks but are least equipped to implement *ex-ante* risk mitigation strategies.

Apart from weather-related events, this study highlights volatile market fluctuation as another important shock type faced by rural farm households. With a considerable degree of market integration of agriculture in Thailand, the effects of global price hikes in output and input are essentially triggered down to rural farm households. Although the price increase of agricultural outputs offers a prospect to increase farm household income, the simultaneous increase in input prices practically offsets the opportunity to intensify agricultural production of cash-crops. As currently observed, intensive reliance of market purchased-inputs such as fuel for mechanization and chemical fertilizer application increases household's susceptibility on the market price variation. Farm households must accept higher cost of production during the cropping period while higher revenue at harvesting is uncertain. An alternative organic crop-livestock farming which supports the application of manure and organic fertilizers in place of chemical fertilizers would not only reduce this market vulnerability but also environmental degradation through less emission of greenhouse gas and lower carbon content in soil (Jitsuchon 2010). Although mechanization is advanced in Thailand, crop-livestock farming can further reduce dependency on fuel, which has become more expensive and its price continues to soar, by partial substitution between mechanical plowing machine and traditional buffalo.

Recognizing the household's objective of assuring food security over cash-income maximization, substitution between cash-crop (i.e. jasmine rice) and non-cash crops (i.e. glutinous rice) needs a substantial price incentive in addition to alternative secured food source. As a result of lower gross margin from agriculture whereas off-farm wage income became relatively more attractive to on-farm earnings, household labor is transferred to off-farm employment. The shifting of on-farm household labor towards off-farm employment may induce a structural change in agriculture where the remaining full-time farm households absorb the land from the part-time farm households. However, this is not the case in Northeast Thailand as compared to the Central region. Possible reasons maybe the rigidity of land ownership which is regarded as a valuable productive asset of a household in a long-term providing subsistence production of home-grown food whereas seasonal off-farm wage employment offers an effective shock-coping measure in the short-run. Furthermore, it is also important to note that the response to output price increase is constrained by the availability of land in order to expand the production of cash crop. This finding is in line with the economic theory that the supply price elasticity is lower in the short-run than in the long-run due to rigidity of input availability as outputs are not only influenced by prices, but also by production factors especially land which are fixed in the short-term (e.g. Binswanger 1989).

Moreover, farm planning requires time in advance. The increase in output price came as a surprise to the farm households most likely at the time after the cropping production for current season had already been begun and there is a high uncertainty that the high price will remain for the next cropping periods. To ensure that the effects of such positive market shocks are realized, public institutions such as the department of internal trade and agricultural cooperatives should provide timely information about the recent market development and reliable market prediction. Based on the model optimization, off-farm wage occupation offers an essential *ex-post* shock-coping strategy for farm households in the short-run which reduces household income variance and contributes to lower vulnerability to poverty. This outcome emphasizes the supportive role of off-farm employment and income source diversification to absorb economic shocks. In order to facilitate the balance of on-farm and off-farm combination and to avoid outmigration including the complete structural shift to off-farm sector, rural development policy should focus on provision of seasonal off-farm employment at the provincial or regional level especially during the cultivation period where labor demand for on-farm production is less intensive.

Although the implication and response to demographic and social shocks and risks are not explicitly elaborated in this thesis, they are no less important and relevant for rural households. In general, initiation and cooperation at the community level from individual households may strengthen the social safety-net to effectively cope with shocks and prepare for risks of any type.

The delegation of public support to community village level allows a quick respond to affected households in a discrete manner. In particular, familiar relationship between household neighbors can be used as a monitoring tool and precautionary alarm system. With a high degree of trust within the social network in the community, information on shock and risk events can be exchanged more effectively leading to a more timely provision of assistance as compared to the usually complicated impersonal procedure from public institutions. Equally important is the availability of and the access to different *ex-ante* and *ex-post* coping measures provided to assist different types of households and to ensure that these measures are undertaken.

Considering state-of-the-art of this thesis, the methodology applied to analyze vulnerability to poverty based on cross-section comparative static of data from two-period panel has contributed to an improved understanding of the nature and effects of shocks and risks on rural households' well-being and response behavior. However, some gaps in information and understanding remain with the available database. Future research is therefore encouraged to extend the analysis to include a longer-period of panel data and to apply appropriate panel data analysis approach in order to thoroughly detect the nature and pattern of transient and chronic poverty. For a future research, it is recommended to apply available vulnerability measurement concepts to estimate the effect of *ex-ante* risk management and *ex-post* shock coping strategies on the vulnerability to poverty of households in order to establish a full linkage between shock experiences, *ex-post* coping actions, subjective risk perception, *ex-ante* risk mitigation and the outcome vulnerability level. By exploring how each *ex-post* shock coping actions and *ex-ante* risk mitigation strategies influence the vulnerability of each type of households, social risk management design can be facilitated to be customized and target-oriented for effective poverty alleviation.

Moreover, this thesis develops and demonstrates the application of alternative approach using mathematical programming models of typical farm households to account for multiple sources of risks, i.e. endogenous weather risks and exogenous market risks, in a theoretically consistent framework. A direct advantage of such typical farm household construction is the flexibility of the sample size. Therefore, this approach is an example of how alternative methodology can be applied to a limited number of sample sizes in a study area where the use of econometric methods is difficult. However, this thesis only offers a case study of one type of typical farm households. Diverse types of typical farm households should be considered in future research in order to assess possible differences in behavioral responses to shocks and their impacts on vulnerability level due to underlying different resource constraints, production technology, activity portfolios and household objectives. In order to realistically capture the seasonality and dynamics of household behavior, it is strongly recommended to extend the model to incorporate multiple periods by means of recursive modeling which accounts for interdependence between

actions and outcomes in different periods. In addition to economic shocks as presented in this thesis, the model can be adjusted to assess the impact of other types of shocks such as demographic, biological and social shocks on the one hand, and policy interventions on the other hand. With a sound typical farm household modeling, policy makers can evaluate the impact of public programs on the behavioral adjustment and vulnerability to poverty of any specific type of households.

In summary, this thesis has demonstrated the implication of shocks and risks on poverty and vulnerability of rural farm households in emerging market economies. To achieve the objective of sustainable poverty reduction in rural areas, policy makers should emphasize the involvement of the poor and incorporate local experiences on the agenda. Considering the expected increase in weather variations, economic crises, biological adversity of new diseases and socio-political instability, the ability to cope with shocks *ex-post* and to prepare for risk *ex-ante* should be enhanced by empowering local community in the designing and implementation of social risk management policy in a multi-sectoral collaborative effort between agricultural, market, statistical and planning institutions. More importantly, effective social risk management and poverty alleviation scheme needs to recognize different characteristics of households in order to customize different *ex-post* shock-coping actions and *ex-ante* risk mitigation strategies to tackle different types of shocks and risks.

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Appendices

Appendix A: Multivariate probit results of coping activity (1st wave, 2007)

Number of obs = 514
Wald chi2(19) = 203.44
Prob > chi2 = 0.0000
Log pseudolikelihood = -604757.72
SML, # draws = 24

1st wave (2007)	Remittance and 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 before shock *(100 PPP$)* [a]	0.0021	0.62	0.0007	-0.0025	-0.66	-0.0007	-0.0051	-1.28	-0.0019	-0.0034	-0.95	-0.0012
Wealth per capita before shock *(100 PPP$)* [a]	-0.0003	-0.91	-0.0001	-0.0007	-1.50	-0.0002	-0.0001	-0.22	0.0000	0.0004	1.26	0.0001
Maximum years of schooling *(Years)*	-0.0270	-1.50	-0.0086	0.0436 **	2.34	0.0121	-0.0058	-0.35	-0.0022	0.0196	1.20	0.0069
agriculture *(%)*	-0.2668	-1.24	-0.0848	-0.2721	-1.17	-0.0755	0.0926	0.46	0.0351	0.0087	0.04	0.0031
Number of migrant member *(Persons)*	0.0244	0.50	0.0078	-0.0869	-1.58	-0.0241	0.0582	1.18	0.0221	0.0014	0.03	0.0005
Shock characteristics												
Income loss per capita												
Agricultural shock *(100 PPP$)* [a]	0.0217	1.02	0.0069	0.1100 ***	3.61	0.0305	-0.0292	-1.30	-0.0111	-0.0516 **	-2.46	-0.0182
Economic shock *(100 PPP$)* [a]	-0.0870 ***	-3.42	-0.0276	0.0342 *	1.87	0.0095	0.0354 *	1.88	0.0134	-0.0024	-0.14	-0.0009
Health shock *(100 PPP$)* [a]	0.0172	1.09	0.0055	-0.0222	-1.00	-0.0062	0.0010	0.08	0.0004	0.0341	1.63	0.0120
Social shock *(100 PPP$)* [a]	0.0137	0.24	0.0043	0.1136 **	1.98	0.0315	0.0275	0.44	0.0104	-0.0467	-1.26	-0.0164
Asset loss per capita												
Agricultural shock *(100 PPP$)* [a]	0.0001	0.01	0.0000	-0.0176	-1.03	-0.0049	0.0260	1.43	0.0099	-0.0037	-0.27	-0.0013
Economic shock *(100 PPP$)* [a]	-0.0463 **	-2.03	-0.0147	0.0059	0.54	0.0016	0.0134	1.12	0.0051	0.0060	0.73	0.0021
Health shock *(100 PPP$)* [a]	0.0180	1.25	0.0057	-0.0494	-1.57	-0.0137	0.0094	0.79	0.0036	0.0325 **	2.53	0.0114
Social shock *(100 PPP$)* [a]	-0.0075	-0.31	-0.0024	-0.0434	-1.17	-0.0120	0.0152	0.69	0.0058	0.0471 ***	2.89	0.0166
Village characteristics												
Distance from village to provincial capital *(Kilometer)*	0.0022	1.16	0.0007	-0.0030	-1.46	-0.0008	0.0022	1.28	0.0008	-0.0010	-0.55	-0.0004
Travelling time to the next market *(Minutes)*	-0.0043	-0.77	-0.0014	0.0016	0.33	0.0004	0.0000	0.00	0.0000	0.0030	0.65	0.0011
Province dummy: *1=Buriram*	-0.4361 **	-2.52	-0.1387	-0.2893 *	-1.70	-0.0803	0.2798 *	1.81	0.1061	-0.1757	-1.10	-0.0618
Province dummy: *1=Nakhon Panom*	-0.5802 ***	-3.58	-0.1845	-0.1757	-1.02	-0.0488	0.4278 ***	2.83	0.1623	0.2404	1.63	0.0846
atrho21	-0.2403 ***	-3.09	rho21	-0.2358 ***	-3.21							
atrho31	-0.5335 ***	-6.91	rho31	-0.4881 ***	-8.30							
atrho41	-0.2578 ***	-3.57	rho41	-0.2523 ***	-3.73							
atrho32	-0.2525 ***	-3.37	rho32	-0.2473 ***	-3.52							
atrho42	-0.2345 ***	-2.87	rho42	-0.2303 ***	-2.98							
atrho43	-0.4097 ***	-5.71	rho43	-0.3882 ***	-6.37							

[a] Measured in *PPP$ (2005)* with conversion factor for THB of 0.0600 (1st wave) and 0.0582 (2nd wave)

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

Source: Own calculation.

Appendix B: Multivariate probit results of coping activity (2nd wave, 2008)

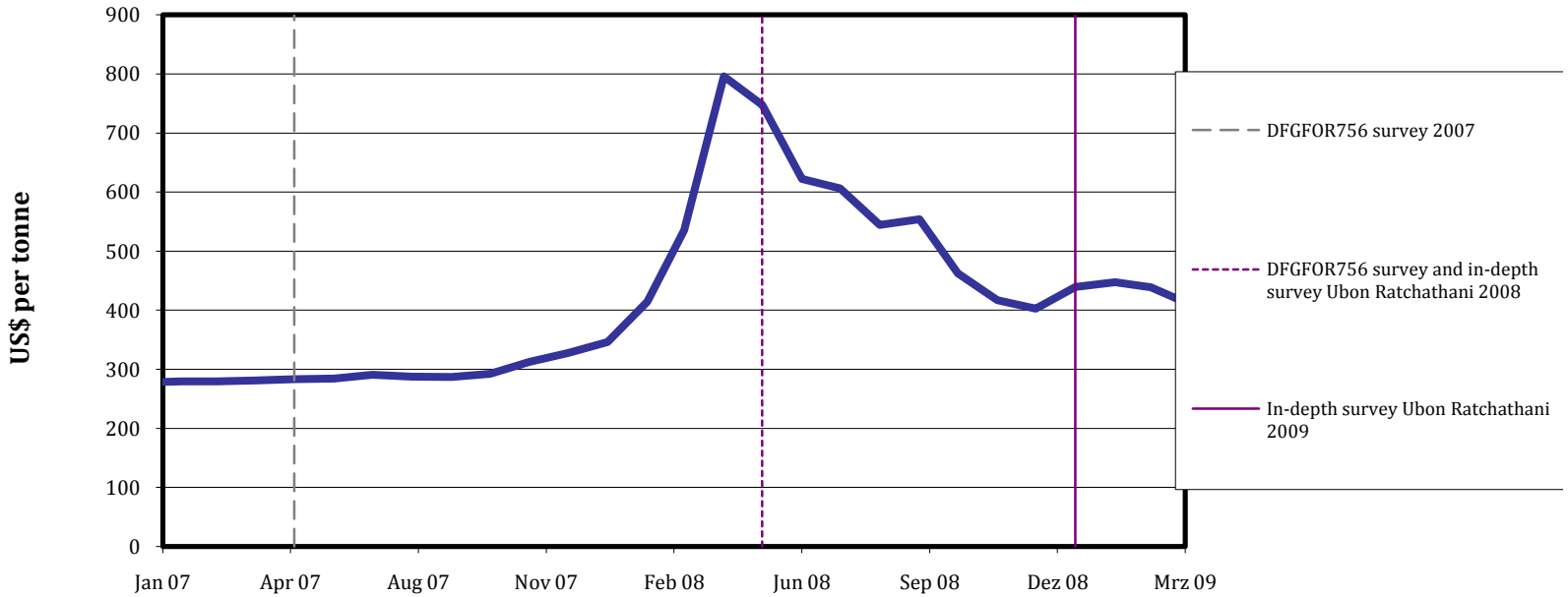
Number of obs = 814
Wald chi2(19) = 186.07
Prob > chi2 = 0.0000
Log pseudolikelihood = -1033705.1
SML, # draws = 30

2nd wave (2008)	Remittance and 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 before shock *(100 PPP$)* [a]	0.0014	0.92	0.0005	-0.0009	-0.67	-0.0003	-0.0026	-1.60	-0.0009	0.0015	1.08	0.0006
Wealth per capita before shock *(100 PPP$)* [a]	-0.0004	-1.26	-0.0001	-0.0006	-1.60	-0.0002	-0.0015 ***	-3.30	-0.0005	0.0010 ***	3.20	0.0004
Maximum years of schooling *(Years)*	-0.0016	-0.12	-0.0005	0.0330 ***	2.64	0.0113	-0.0046	-0.34	-0.0015	-0.0089	-0.72	-0.0034
agriculture *(%)*	-0.1063	-0.59	-0.0347	0.2403	1.39	0.0821	0.1794	1.00	0.0598	-0.3225 **	-2.00	-0.1241
Number of migrant member *(Persons)*	0.0540 *	1.68	0.0176	0.0142	0.46	0.0049	0.0153	0.48	0.0051	-0.0160	-0.58	-0.0062
Shock characteristics												
Income loss per capita												
Agricultural shock *(100 PPP$)* [a]	-0.0028	-0.21	-0.0009	0.0305 **	2.28	0.0104	0.0420 ***	2.72	0.0140	-0.0121	-0.96	-0.0046
Economic shock *(100 PPP$)* [a]	-0.0119	-1.16	-0.0039	0.0029	0.76	0.0010	0.0191 *	1.82	0.0064	-0.0066 *	-1.88	-0.0025
Health shock *(100 PPP$)* [a]	0.0114	0.63	0.0037	0.0072	0.50	0.0025	0.0482 **	2.40	0.0161	0.0163	1.04	0.0063
Social shock *(100 PPP$)* [a]	0.0063	0.33	0.0020	0.0075	0.40	0.0026	0.0432	1.33	0.0144	-0.0241	-1.31	-0.0093
Asset loss per capita												
Agricultural shock *(100 PPP$)* [a]	0.0504 **	2.42	0.0165	0.0088	0.31	0.0030	0.0151	0.58	0.0050	-0.0129	-0.46	-0.0049
Economic shock *(100 PPP$)* [a]	-0.2458	-1.35	-0.0802	-0.0067	-0.32	-0.0023	-0.0893	-1.55	-0.0298	0.0755	0.90	0.0291
Health shock *(100 PPP$)* [a]	-0.0083	-0.59	-0.0027	0.0058	0.52	0.0020	-0.0034	-0.16	-0.0011	0.0019	0.16	0.0007
Social shock *(100 PPP$)* [a]	-0.1305 *	-1.85	-0.0426	0.0098	0.59	0.0033	0.0513 *	2.03	0.0171	0.0048	0.27	0.0018
Village characteristics												
Distance from village to provincial capital *(Kilometer)*	-0.0006	-0.44	-0.0002	-0.0028 *	-1.89	-0.0009	-0.0018	-1.23	-0.0006	0.0026 *	1.90	0.0010
Travelling time to the next market *(Minutes)*	-0.0064	-1.31	-0.0021	0.0000	0.01	0.0000	0.0093 **	2.30	0.0031	-0.0033	-0.79	-0.0013
Province dummy: *1=Buriram*	0.3294 **	2.35	0.1074	0.2388 *	1.80	0.0816	-0.3085 **	-2.34	-0.1029	-0.1608	-1.27	-0.0619
Province dummy: *1=Nakhon Panom*	-0.0179	-0.14	-0.0058	0.2429 *	1.85	0.0830	-0.0073	-0.06	-0.0024	-0.1286	-1.02	-0.0495
atrho21	-0.2992 ***	-5.20	rho21	-0.2906 ***	-5.52							
atrho31	-0.2470 ***	-4.21	rho31	-0.2421 ***	-4.38							
atrho41	-0.4051 ***	-6.66	rho41	-0.3843 ***	-7.41							
atrho32	-0.1875 ***	-3.22	rho32	-0.1853 ***	-3.30							
atrho42	-0.4249 ***	-7.31	rho42	-0.4011 ***	-8.22							
atrho43	-0.1903 ***	-3.32	rho43	-0.1880 ***	-3.40							

[a] Measured in *PPP$ (2005)* with conversion factor for THB of 0.0600 (1st wave) and 0.0582 (2nd wave)

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
Source: Own calculation.

Appendix C: Monthly rice prices in Thailand 2007-2009



Note: 25% broken rice wholesale price in Bangkok.

Source: Bank of Thailand, available at **http://www.bot.or.th**, accessed in March 2011

Appendix D: LP matrix 2007 (upper part)

			Common input				Jasmine rice				Glutinous rice			Veg			Cassava	
LP Model: 2007			Chem Fertilizer	Manure	Org Fertilizer	Fuel	Production	Sell	Consume	Buy	Production	Consume	Buy	Production	Consume	Buy	Production	Sell
Unit of analysis			kg	kg	kg	liter	ha	kg	kg	kg	ha	kg	kg	ha	kg	kg	ha	kg
			chem_fert	manure	org_fert	fuel	jas	sell_jas	cons_jas	buy_jas	glu	cons_glu	buy_glu	veg	cons_veg	buy_veg	cas	sell_cas
Objective function	**PPP$**		**-1.001**		**-0.291**	**-1.455**	**571.18**	**0.524**	**0.524**	**-1.07**	**395.93**	**0.466**	**-1.21**	**440.74**	**0.495**	**-1.17**	**557.06**	**0.160**
	Unit		chem_fert	manure	org_fert	fuel	jas	sell_jas	cons_jas	buy_jas	glu	cons_glu	buy_glu	veg	cons_veg	buy_veg	cas	sell_cas
Chemical fertilizer	kg	cfert_bal	1				-94.95				-123.58			0			-250	
Manure	kg	man_bal		1			-245.00				-491.00			-313				
Organic fertilizer	kg	ofert_bal			1		-178.82				-276.91			-50			-468.75	
Fuel	liter	fuel_bal				1	-15.63				-15.39			0			-20.31	
Jasmine rice balance (yield)	kg	jas_bal					1958.1	-1	-1									
Jasmine rice consumption needs	kg	jas_cons_cstr							1	1								
Glutinous rice balance	kg	glu_bal									1527	-1						
Glutinous rice consumption needs	kg	glu_cons_cstr										1	1					
Veg balance	kg	veg_bal												1599.79	-1			
Veg consumption needs	kg	veg_cons_cstr													1	1		
Cassava balance	kg	cas_bal															6250	-1
Buffalo balance	head	buff_bal																
Cattle balance	head	catt_bal																
Chicken balance	head	chic_bal																
Chicken consumption need	head	chic_cons_cstr																
Land constraint rice cassava	ha	land_rice_cas					1				1						1	
Land balance rice	ha	land_bal_rice					1				-1						-1	
Land constraint veg	ha	land_veg												1				
Land constraint buffalo cattle	m2	land_buff_catt																
Land constraint chicken	m2	land_chic																
Hard labor constraint Jan	mandays	hlab_cstr1																
Hard labor constraint Feb	mandays	hlab_cstr2																
Hard labor constraint Mar	mandays	hlab_cstr3												25.00				
Hard labor constraint Apr	mandays	hlab_cstr4					0.33				0.35			23.44			3.13	
Hard labor constraint May	mandays	hlab_cstr5					6.51				3.65							
Hard labor constraint Jun	mandays	hlab_cstr6					3.01				6.88							
Hard labor constraint Jul	mandays	hlab_cstr7					3.32				2.05							
Hard labor constraint Aug	mandays	hlab_cstr8					11.33				13.54							
Hard labor constraint Sep	mandays	hlab_cstr9																
Hard labor constraint Oct	mandays	hlab_cstr10																
Hard labor constraint Nov	mandays	hlab_cstr11												37.50				
Hard labor constraint Dec	mandays	hlab_cstr12												1.56				

Appendix D: LP matrix 2007 (upper part), cont.

Buffalo		Cattle		Chicken			Off-farm employment												Hard labor transfer						
Variable costs	Sell	Variable costs	Sell	Variable costs	Consume	Sell	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Jan	Feb	Mrz	Apr	Mai	Jun	Jul
head	head	head	head	head	head	head	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days
buff	sell_buff	catt	sell_catt	chic	cons_chic	sell_chic	off_1	off_2	off_3	off_4	off_5	off_6	off_7	off_8	off_9	off_10	off_11	off_12	hlab_trans1	hlab_trans2	hlab_trans3	hlab_trans4	hlab_trans5	hlab_trans6	hlab_trans7
-9.47	**785.70**	**-4.78**	**523.80**	**-2.17**	**3.38**	**3.38**	**8.38**	**8.38**	**8.85**	**8.38**	**9.31**	**9.89**	**10.48**	**10.48**	**10.48**	**9.89**	**9.31**	**8.38**							
buff	sell_buff	catt	sell_catt	chic	cons_chic	sell_chic	off_1	off_2	off_3	off_4	off_5	off_6	off_7	off_8	off_9	off_10	off_11	off_12	hlab_trans1	hlab_trans2	hlab_trans3	hlab_trans4	hlab_trans5	hlab_trans6	hlab_trans7
11.6		15.65																							
232		313																							
-1	4																								
		-1	4																						
				-0.86	1	1																			
					1																				
5.15		3.375																							
				0.125																					
																			1						
																				1					
																					1				
																						1			
																							1		
																								1	
																									1

Appendix D: LP matrix 2007 (upper part), cont.

Hard labor transfer					Further consumption	Transfer cash surplus											Negative deviation				ome from remittances	Income from house homestead	Income from natural resource	Asset depreciation	Asset cost	Expenditure			RHS		Probability of occurence
Aug	Sep	Okt	Nov	Dez		1	2	3	4	5	6	7	8	9	10	11	Risk 1	Risk 2	Risk 3	Risk 4											
man days	man days	man days	man days	man days	PPP$	PPP$											PPP$				PPP$										
hlab_trans8	hlab_trans9	hlab_trans10	hlab_trans11	hlab_trans12	fcons	trans1	trans2	trans3	trans4	trans5	trans6	trans7	trans8	trans9	trans10	trans11	negdev1	negdev2	negdev3	negdev4	inc_remit	inc_house	inc_nat	asset_dep	asset_cost	exp_cost					
																					1	1	1	-1	-1	-1					
hlab_trans8	hlab_trans9	hlab_trans10	hlab_trans11	hlab_trans12	fcons	trans1	trans2	trans3	trans4	trans5	trans6	trans7	trans8	trans9	trans10	trans11	negdev1	negdev2	negdev3	negdev4	inc_remit	inc_house	inc_nat	asset_dep	asset_cost	exp_cost					
																											>=	cfert_bal	0		
																											>=	man_bal	0		
																											>=	ofert_bal	0		
																											>=	fuel_bal	0		
																											>=	jas_bal	0		
																											=	jas_cons_cstr	600.96		
																											>=	glu_bal	0		
																											=	glu_cons_cstr	1122.5		
																											>=	veg_bal	0		
																											=	veg_cons_cstr	234.375		
																											>=	cas_bal	0		
																											<=	buff_bal	0		
																											<=	catt_bal	0		
																											<=	chic_bal	0		
																											=	chic_cons_cstr	5		
																											<=	land_rice_cas	3.58		
																											<=	land_bal_rice	0		
																											<=	land_veg	0.08		
																											<=	land_buff_catt	30.71		
																											<=	land_chic	20		
																											<=	hlab_cstr1	30		
																											<=	hlab_cstr2	30		
																											<=	hlab_cstr3	30		
																											<=	hlab_cstr4	30		
																											<=	hlab_cstr5	30		
																											<=	hlab_cstr6	30		
																											<=	hlab_cstr7	30		
1																											<=	hlab_cstr8	30		
	1																										<=	hlab_cstr9	30		
		1																									<=	hlab_cstr10	30		
			1																								<=	hlab_cstr11	30		
				1																							<=	hlab_cstr12	30		

Appendix E: LP matrix 2007 (lower part)

Mixed labour constraint Jan	mandays	mlab_cstr1														41.02	
Mixed labor constraint Feb	mandays	mlab_cstr2															
Mixed labor constraint Mar	mandays	mlab_cstr3											26.56				
Mixed labor constraint Apr	mandays	mlab_cstr4					0.20				0.22		17.58				
Mixed labor constraint May	mandays	mlab_cstr5					7.81				11.13		23.44			9.38	
Mixed labor constraint Jun	mandays	mlab_cstr6					0.50				0.65		37.50			18.75	
Mixed labor constraint Jul	mandays	mlab_cstr7					0.78				0.38		42.19				
Mixed labor constraint Aug	mandays	mlab_cstr8					0.52				0.52		18.75			0.33	
Mixed labor constraint Sep	mandays	mlab_cstr9					2.34				2.41					0.33	
Mixed labor constraint Oct	mandays	mlab_cstr10					21.88				24.28						
Mixed labor constraint Nov	mandays	mlab_cstr11					27.78				30.00		28.13				
Mixed labor constraint Dec	mandays	mlab_cstr12					5.21						18.75			29.79	
Consumption constraint Jan	PPP$	cons_cstr1															
Consumption constraint Feb	PPP$	cons_cstr2															
Consumption constraint Mar	PPP$	cons_cstr3															
Consumption constraint Apr	PPP$	cons_cstr4															
Consumption constraint May	PPP$	cons_cstr5															
Consumption constraint Jun	PPP$	cons_cstr6															
Consumption constraint Jul	PPP$	cons_cstr7															
Consumption constraint Aug	PPP$	cons_cstr8															
Consumption constraint Sep	PPP$	cons_cstr9															
Consumption constraint Oct	PPP$	cons_cstr10															
Consumption constraint Nov	PPP$	cons_cstr11															
Consumption constraint Dec	PPP$	cons_cstr12															
Cash constraint January	PPP$	cash_cstr1													1.2		-0.160
Cash constraint February	PPP$	cash_cstr2															
Cash constraint March	PPP$	cash_cstr3			0.291												
Cash constraint April	PPP$	cash_cstr4	1.001		0.291	1.455				1.067		1.213			1.2		
Cash constraint May	PPP$	cash_cstr5	1.001		0.291	1.455											
Cash constraint June	PPP$	cash_cstr6	1.001		0.291	1.455											
Cash constraint July	PPP$	cash_cstr7	1.001		0.291	1.455									1.2		
Cash constraint August	PPP$	cash_cstr8	1.001		0.291	1.455				1.067		1.213					
Cash constraint September	PPP$	cash_cstr9			0.291												
Cash constraint October	PPP$	cash_cstr10						-0.524							1.2		
Cash constraint November	PPP$	cash_cstr11						-0.524									
Cash constraint December	PPP$	cash_cstr12						-0.524									
Yield risk state 1 (no shock)	PPP$	risk1					1025.67				710.97		791.43			1000.31	
Yield risk state 2 (drought)	PPP$	risk2					195.30				135.38		150.70			190.48	
Yield risk state 3 (flood)	PPP$	risk3					354.98				246.06		273.91			346.20	
Yield risk state 4 (drought, flood)	PPP$	risk4					32.81				22.74		25.32			32.00	
Expected shortfall from target		shortfall															
Income from remittances balance	PPP$	inc_remit_bal															
Income from house and homestead	PPP$	inc_house_bal															
Income from natural resource balance	PPP$	inc_nat_bal															
Asset depreciation balance	PPP$	asset_dep_bal															
Asset cost	PPP$	asset_cost_bal															
Expenditure	PPP$	exp_bal															

Appendix E: LP matrix 2007 (lower part), cont.

1.6		2		0.29			1												-1						
1.6		2		0.29				1												-1					
1.6		2		0.29					1												-1				
1.6		2		0.29						1												-1			
1.6		2		0.29							1												-1		
1.6		2		0.29								1												-1	
1.6		2		0.29									1												-1
1.6		2		0.29										1											
1.6		2		0.29											1										
1.6		2		0.29												1									
1.6		2		0.29													1								
1.6		2		0.29														1							
0.79	-65.475	0.40	-43.65	0.18		-0.28	-8.38																		
0.79	-65.475	0.40	-43.65	0.18		-0.28		-8.38																	
0.79	-65.475	0.40	-43.65	0.18		-0.28			-8.85																
0.79	-65.475	0.40	-43.65	0.18		-0.28				-8.38															
0.79	-65.475	0.40	-43.65	0.18		-0.28					-9.31														
0.79	-65.475	0.40	-43.65	0.18		-0.28						-9.89													
0.79	-65.475	0.40	-43.65	0.18		-0.28							-10.48												
0.79	-65.475	0.40	-43.65	0.18		-0.28								-10.48											
0.79	-65.475	0.40	-43.65	0.18		-0.28									-10.48										
0.79	-65.475	0.40	-43.65	0.18		-0.28										-9.89									
0.79	-65.475	0.40	-43.65	0.18		-0.28											-9.31								
0.79	-65.475	0.40	-43.65	0.18		-0.28												-8.38							
-9.47	785.70	-4.78	523.80	-2.17	3.38	3.38	8.38	8.38	8.85	8.38	9.31	9.89	10.48	10.48	10.48	9.89	9.31	8.38							
-9.47	785.70	-4.78	523.80	-2.17	3.38	3.38	8.38	8.38	8.85	8.38	9.31	9.89	10.48	10.48	10.48	9.89	9.31	8.38							
-9.47	785.70	-4.78	523.80	-2.17	3.38	3.38	8.38	8.38	8.85	8.38	9.31	9.89	10.48	10.48	10.48	9.89	9.31	8.38							
-9.47	785.70	-4.78	523.80	-2.17	3.38	3.38	8.38	8.38	8.85	8.38	9.31	9.89	10.48	10.48	10.48	9.89	9.31	8.38							

Appendix E: LP matrix 2007 (lower part), cont.

																									<=	mlab_cstr1	45		
																									<=	mlab_cstr2	45		
																									<=	mlab_cstr3	45		
																									<=	mlab_cstr4	60		
																									<=	mlab_cstr5	60		
																									<=	mlab_cstr6	45		
																									<=	mlab_cstr7	45		
-1																									<=	mlab_cstr8	45		
	-1																								<=	mlab_cstr9	45		
		-1																							<=	mlab_cstr10	60		
			-1																						<=	mlab_cstr11	60		
				-1																					<=	mlab_cstr12	60		
					1																				>=	cons_cstr1	50.64		
					1																				>=	cons_cstr2	50.64		
					1																				>=	cons_cstr3	50.64		
					1																				>=	cons_cstr4	50.64		
					1																				>=	cons_cstr5	50.64		
					1																				>=	cons_cstr6	50.64		
					1																				>=	cons_cstr7	50.64		
					1																				>=	cons_cstr8	50.64		
					1																				>=	cons_cstr9	50.64		
					1																				>=	cons_cstr10	50.64		
					1																				>=	cons_cstr11	50.64		
					1																				>=	cons_cstr12	50.64		
					1	1																			<=	cash_cstr1	341.52		
					1	-1	1																		<=	cash_cstr2	0		
					1		-1	1																	<=	cash_cstr3	0		
					1			-1	1																<=	cash_cstr4	0		
					1				-1	1															<=	cash_cstr5	0		
					1					-1	1														<=	cash_cstr6	0		
					1						-1	1													<=	cash_cstr7	0		
					1							-1	1												<=	cash_cstr8	0		
					1								-1	1											<=	cash_cstr9	0		
					1									-1	1										<=	cash_cstr10	0		
					1										-1	1									<=	cash_cstr11	0		
					1											-1									<=	cash_cstr12	341.52		
																	1				1	1	1	-1	-1	-1	>=	risk1	4411.7	risk1	0.43
																		1			1	1	1	-1	-1	-1	>=	risk2	4411.7	risk2	0.21
																			1		1	1	1	-1	-1	-1	>=	risk3	4411.7	risk3	0.24
																				1	1	1	1	-1	-1	-1	>=	risk4	4411.7	risk4	0.12
																0.43	0.21	0.24	0.12								<=	shortfall	**600**		
																				1							=	inc_remit_bal	46.7		
																					1						=	inc_house_bal	498		
																						1					=	inc_nat_bal	116.3		
																							1				=	asset_dep_bal	181		
																								1			=	asset_cost_bal	21		
																										1	=	exp_bal	2845.3		

Appendix F: LP matrix 2008 (upper part)

			Common input				Jasmine rice				Glutinous rice			Veg			Cassava	
LP Model: 2007			Chem Fertilizer	Manure	Org Fertilizer	Fuel	Production	Sell	Consume	Buy	Production	Consume	Buy	Production	Consume	Buy	Production	Sell
Unit of analysis			kg	kg	kg	liter	ha	kg	kg	kg	ha	kg	kg	ha	kg	kg	ha	kg
			chem_fert	manure	org_fert	fuel	jas	sell_jas	cons_jas	buy_jas	glu	cons_glu	buy_glu	veg	cons_veg	buy_veg	cas	sell_cas
Objective function	**PPP$**		**-1.310**		**-0.328**	**-2.075**	**578.20**	**0.683**	**0.683**	**-1.37**	**371.63**	**0.564**	**-0.82**	**681.02**	**0.764**	**-1.16**	**521.40**	**0.137**
	Unit		chem_fert	manure	org_fert	fuel	jas	sell_jas	cons_jas	buy_jas	glu	cons_glu	buy_glu	veg	cons_veg	buy_veg	cas	sell_cas
Chemical fertilizer	kg	cfert_bal	1				-94.95				-123.58			0			-250	
Manure	kg	man_bal		1			-245.00				-491.00			-313				
Organic fertilizer	kg	ofert_bal			1		-178.82				-276.91			-50			-468.75	
Fuel	liter	fuel_bal				1	-15.63				-15.39			0			-20.31	
Jasmine rice balance (yield)	kg	jas_bal					1958.1	-1	-1									
Jasmine rice consumption needs	kg	jas_cons_cstr							1	1								
Glutinous rice balance	kg	glu_bal									1527	-1						
Glutinous rice consumption needs	kg	glu_cons_cstr										1	1					
Veg balance	kg	veg_bal												1599.79	-1			
Veg consumption needs	kg	veg_cons_cstr													1	1		
Cassava balance	kg	cas_bal															6250	-1
Buffalo balance	head	buff_bal																
Cattle balance	head	catt_bal																
Chicken balance	head	chic_bal																
Chicken consumption need	head	chic_cons_cstr																
Land constraint rice cassava	ha	land_rice_cas					1				1						1	
Land balance rice	ha	land_bal_rice					1				-1						-1	
Land constraint veg	ha	land_veg												1				
Land constraint buffalo cattle	m2	land_buff_catt																
Land constraint chicken	m2	land_chic																
Hard labor constraint Jan	mandays	hlab_cstr1																
Hard labor constraint Feb	mandays	hlab_cstr2																
Hard labor constraint Mar	mandays	hlab_cstr3												25.00				
Hard labor constraint Apr	mandays	hlab_cstr4					0.33				0.35			23.44			3.13	
Hard labor constraint May	mandays	hlab_cstr5					6.51				3.65							
Hard labor constraint Jun	mandays	hlab_cstr6					3.01				6.88							
Hard labor constraint Jul	mandays	hlab_cstr7					3.32				2.05							
Hard labor constraint Aug	mandays	hlab_cstr8					11.33				13.54							
Hard labor constraint Sep	mandays	hlab_cstr9																
Hard labor constraint Oct	mandays	hlab_cstr10																
Hard labor constraint Nov	mandays	hlab_cstr11												37.50				
Hard labor constraint Dec	mandays	hlab_cstr12												1.56				

Appendix F: LP matrix 2008 (upper part), cont.

Buffalo		Cattle		Chicken			Off-farm employment												Hard labor transfer						
Variable costs	Sell	Variable costs	Sell	Variable costs	Consume	Sell	Jan	Feb	Mrz	Apr	Mai	Jun	Jul	Aug	Sep	Okt	Nov	Dez	Jan	Feb	Mrz	Apr	Mai	Jun	Jul
head	head	head	head	head	head	head	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days	man days
buff	sell_buff	catt	sell_catt	chic	cons_chic	sell_chic	off_1	off_2	off_3	off_4	off_5	off_6	off_7	off_8	off_9	off_10	off_11	off_12	hlab_trans1	hlab_trans2	hlab_trans3	hlab_trans4	hlab_trans5	hlab_trans6	hlab_trans7
-8.88	**737.1**	**-4.48**	**491.4**	**-2.03**	**3.17**	**3.17**	**7.86**	**7.86**	**8.30**	**7.86**	**8.74**	**9.28**	**9.83**	**9.83**	**9.83**	**9.28**	**8.74**	**7.86**							
buff	sell_buff	catt	sell_catt	chic	cons_chic	sell_chic	off_1	off_2	off_3	off_4	off_5	off_6	off_7	off_8	off_9	off_10	off_11	off_12	hlab_trans1	hlab_trans2	hlab_trans3	hlab_trans4	hlab_trans5	hlab_trans6	hlab_trans7
11.6		15.65																							
232		313																							
-1	4																								
		-1	4																						
				-0.86	1	1																			
					1																				
5.15		3.375																							
				0.125																					
																			1						
																				1					
																					1				
																						1			
																							1		
																								1	
																									1

Appendix F: LP matrix 2008 (upper part), cont.

Hard labor transfer Aug	Sep	Okt	Nov	Dez	Further consumption	Transfer cash surplus 1	2	3	4	5	6	7	8	9	10	11	Negative deviation Risk 1	Risk 2	Risk 3	Risk 4	ome from remittances	Income from house homestead	Income from natural resource	Asset depreciation	Asset cost	Expenditure			RHS		Probability of occurence
man days	man days	man days	man days	man days	PPP$	PPP$											PPP$				PPP$										
hlab_trans8	hlab_trans9	hlab_trans10	hlab_trans11	hlab_trans12	fcons	trans1	trans2	trans3	trans4	trans5	trans6	trans7	trans8	trans9	trans10	trans11	negdev1	negdev2	negdev3	negdev4	inc_remit	inc_house	inc_nat	asset_dep	asset_cost	exp_cost					
																					1	1	1	-1	-1	-1					
hlab_trans8	hlab_trans9	hlab_trans10	hlab_trans11	hlab_trans12	fcons	trans1	trans2	trans3	trans4	trans5	trans6	trans7	trans8	trans9	trans10	trans11	negdev1	negdev2	negdev3	negdev4	inc_remit	inc_house	inc_nat	asset_dep	asset_cost	exp_cost					
																											>=	cfert_bal	0		
																											>=	man_bal	0		
																											>=	ofert_bal	0		
																											>=	fuel_bal	0		
																											>=	jas_bal	0		
																											=	jas_cons_cstr	600.96		
																											>=	glu_bal	0		
																											=	glu_cons_cstr	1122.5		
																											>=	veg_bal	0		
																											=	veg_cons_cstr	234.375		
																											>=	cas_bal	0		
																											<=	buff_bal	0		
																											<=	catt_bal	0		
																											<=	chic_bal	0		
																											=	chic_cons_cstr	5		
																											<=	land_rice_cas	3.58		
																											<=	land_bal_rice	0		
																											<=	land_veg	0.08		
																											<=	land_buff_catt	30.71		
																											<=	land_chic	20		
																											<=	hlab_cstr1	30		
																											<=	hlab_cstr2	30		
																											<=	hlab_cstr3	30		
																											<=	hlab_cstr4	30		
																											<=	hlab_cstr5	30		
																											<=	hlab_cstr6	30		
																											<=	hlab_cstr7	30		
1																											<=	hlab_cstr8	30		
	1																										<=	hlab_cstr9	30		
		1																									<=	hlab_cstr10	30		
			1																								<=	hlab_cstr11	30		
				1																							<=	hlab_cstr12	30		

Appendix G: LP matrix 2008 (lower part)

Mixed labor constraint Jan	mandays	mlab_cstr1														41.02	
Mixed labor constraint Feb	mandays	mlab_cstr2															
Mixed labor constraint Mar	mandays	mlab_cstr3											26.56				
Mixed labor constraint Apr	mandays	mlab_cstr4					0.20				0.22		17.58				
Mixed labor constraint May	mandays	mlab_cstr5					7.81				11.13		23.44			9.38	
Mixed labor constraint Jun	mandays	mlab_cstr6					0.50				0.65		37.50			18.75	
Mixed labor constraint Jul	mandays	mlab_cstr7					0.78				0.38		42.19				
Mixed labor constraint Aug	mandays	mlab_cstr8					0.52				0.52		18.75			0.33	
Mixed labor constraint Sep	mandays	mlab_cstr9					2.34				2.41					0.33	
Mixed labor constraint Oct	mandays	mlab_cstr10					21.88				24.28						
Mixed labor constraint Nov	mandays	mlab_cstr11					27.78				30.00		28.13				
Mixed labor constraint Dec	mandays	mlab_cstr12					5.21						18.75			29.79	
Consumption constraint Jan	PPP$	cons_cstr1															
Consumption constraint Feb	PPP$	cons_cstr2															
Consumption constraint Mar	PPP$	cons_cstr3															
Consumption constraint Apr	PPP$	cons_cstr4															
Consumption constraint May	PPP$	cons_cstr5															
Consumption constraint Jun	PPP$	cons_cstr6															
Consumption constraint Jul	PPP$	cons_cstr7															
Consumption constraint Aug	PPP$	cons_cstr8															
Consumption constraint Sep	PPP$	cons_cstr9															
Consumption constraint Oct	PPP$	cons_cstr10															
Consumption constraint Nov	PPP$	cons_cstr11															
Consumption constraint Dec	PPP$	cons_cstr12															
Cash constraint January	PPP$	cash_cstr1													1.2		-0.137
Cash constraint February	PPP$	cash_cstr2															
Cash constraint March	PPP$	cash_cstr3			0.328												
Cash constraint April	PPP$	cash_cstr4	1.31		0.328	2.075				1.367		0.818			1.2		
Cash constraint May	PPP$	cash_cstr5	1.31		0.328	2.075											
Cash constraint June	PPP$	cash_cstr6	1.31		0.328	2.075											
Cash constraint July	PPP$	cash_cstr7	1.31		0.328	2.075									1.2		
Cash constraint August	PPP$	cash_cstr8	1.31		0.328	2.075				1.367		0.818					
Cash constraint September	PPP$	cash_cstr9			0.328												
Cash constraint October	PPP$	cash_cstr10						-0.683							1.2		
Cash constraint November	PPP$	cash_cstr11						-0.683									
Cash constraint December	PPP$	cash_cstr12						-0.683									
Yield risk state 1 (no shock)	PPP$	risk1					1028.02				662.51		1222.90			936.27	
Yield risk state 2 (drought)	PPP$	risk2					204.32				130.18		232.86			178.28	
Yield risk state 3 (flood)	PPP$	risk3					371.37				236.61		423.24			324.04	
Yield risk state 4 (drought, flood)	PPP$	risk4					34.33				21.87		39.12			29.95	
Expected shortfall from target		shortfall															
Income from remittances balance	PPP$	inc_remit_bal															
Income from house and homestead	PPP$	inc_house_bal															
Income from natural resource balance	PPP$	inc_nat_bal															
Asset depreciation balance	PPP$	asset_dep_bal															
Asset cost	PPP$	asset_cost_bal															
Expenditure	PPP$	exp_bal															

Appendix G: LP matrix 2008 (lower part), cont.

1.6		2		0.29			1												-1						
1.6		2		0.29				1												-1					
1.6		2		0.29					1												-1				
1.6		2		0.29						1												-1			
1.6		2		0.29							1												-1		
1.6		2		0.29								1												-1	
1.6		2		0.29									1												-1
1.6		2		0.29										1											
1.6		2		0.29											1										
1.6		2		0.29												1									
1.6		2		0.29													1								
1.6		2		0.29														1							
0.74	-61.43	0.37	-40.95	0.17		-0.26	-7.86																		
0.74	-61.43	0.37	-40.95	0.17		-0.26		-7.86																	
0.74	-61.43	0.37	-40.95	0.17		-0.26			-8.30																
0.74	-61.43	0.37	-40.95	0.17		-0.26				-7.86															
0.74	-61.43	0.37	-40.95	0.17		-0.26					-8.74														
0.74	-61.43	0.37	-40.95	0.17		-0.26						-9.28													
0.74	-61.43	0.37	-40.95	0.17		-0.26							-9.83												
0.74	-61.43	0.37	-40.95	0.17		-0.26								-9.83											
0.74	-61.43	0.37	-40.95	0.17		-0.26									-9.83										
0.74	-61.43	0.37	-40.95	0.17		-0.26										-9.28									
0.74	-61.43	0.37	-40.95	0.17		-0.26											-8.74								
0.74	-61.43	0.37	-40.95	0.17		-0.26												-7.86							
-8.88	737.10	-4.48	491.40	-2.03	3.17	3.17	7.86	7.86	8.30	7.86	8.74	9.28	9.83	9.83	9.83	9.28	8.74	7.86							
-8.88	737.10	-4.48	491.40	-2.03	3.17	3.17	7.86	7.86	8.30	7.86	8.74	9.28	9.83	9.83	9.83	9.28	8.74	7.86							
-8.88	737.10	-4.48	491.40	-2.03	3.17	3.17	7.86	7.86	8.30	7.86	8.74	9.28	9.83	9.83	9.83	9.28	8.74	7.86							
-8.88	737.10	-4.48	491.40	-2.03	3.17	3.17	7.86	7.86	8.30	7.86	8.74	9.28	9.83	9.83	9.83	9.28	8.74	7.86							

Appendix G: LP matrix 2008 (lower part), cont.

																									<=	mlab_cstr1	45		
																									<=	mlab_cstr2	45		
																									<=	mlab_cstr3	45		
																									<=	mlab_cstr4	60		
																									<=	mlab_cstr5	60		
																									<=	mlab_cstr6	45		
																									<=	mlab_cstr7	45		
-1																									<=	mlab_cstr8	45		
	-1																								<=	mlab_cstr9	45		
		-1																							<=	mlab_cstr10	60		
			-1																						<=	mlab_cstr11	60		
				-1																					<=	mlab_cstr12	60		
					1																				>=	cons_cstr1	47.51		
					1																				>=	cons_cstr2	47.51		
					1																				>=	cons_cstr3	47.51		
					1																				>=	cons_cstr4	47.51		
					1																				>=	cons_cstr5	47.51		
					1																				>=	cons_cstr6	47.51		
					1																				>=	cons_cstr7	47.51		
					1																				>=	cons_cstr8	47.51		
					1																				>=	cons_cstr9	47.51		
					1																				>=	cons_cstr10	47.51		
					1																				>=	cons_cstr11	47.51		
					1																				>=	cons_cstr12	47.51		
					1	1																			<=	cash_cstr1	319.32		
					1	-1	1																		<=	cash_cstr2	0		
					1		-1	1																	<=	cash_cstr3	0		
					1			-1	1																<=	cash_cstr4	0		
					1				-1	1															<=	cash_cstr5	0		
					1					-1	1														<=	cash_cstr6	0		
					1						-1	1													<=	cash_cstr7	0		
					1							-1	1												<=	cash_cstr8	0		
					1								-1	1											<=	cash_cstr9	0		
					1									-1	1										<=	cash_cstr10	0		
					1										-1	1									<=	cash_cstr11	0		
					1											-1									<=	cash_cstr12	319.32		
																	1				1	1	1	-1	-1	-1	>=	risk1	4411.7	risk1	0.43
																		1			1	1	1	-1	-1	-1	>=	risk2	4411.7	risk2	0.21
																			1		1	1	1	-1	-1	-1	>=	risk3	4411.7	risk3	0.24
																				1	1	1	1	-1	-1	-1	>=	risk4	4411.7	risk4	0.12
																0.43	0.21	0.24	0.12								<=	shortfall	**600**		
																				1							=	inc_remit_bal	43.7		
																					1						=	inc_house_bal	465.6		
																						1					=	inc_nat_bal	108.8		
																							1				=	asset_dep_bal	169.2		
																								1			=	asset_cost_bal	19.7		
																										1	=	exp_bal	2669.3		