HOUSEHOLD BARGAINING, SHOCKS AND VULNERABILITY IN THE MEKONG REGION

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Zusammenfassung

Die Mekong Region in Südostasien hat in den letzten Jahrzehnten ein starkes Wirtschaftswachstum erlebt. Ähnlich wie in vielen anderen Regionen profitieren von diesem Wachstum jedoch nicht alle Menschen gleichermaßen. Das Wohlstandsgefälle, sowohl zwischen einzelnen Staaten, als auch zwischen der Stadt- und der Landbevölkerung innerhalb eines Landes, ist groß. Während sich in großen urbanen Zentren, wie beispielsweise Bangkok oder Ho Chi Minh Stadt, viele neue Arbeitsmöglichkeiten ergeben, erwirtschaften Haushalte auf dem Land einen Großteil ihres Lebensunterhalts nach wie vor in der Landwirtschaft und durch den Abbau von natürlichen Ressourcen. Durch den Anstieg und die stärkeren Auswirkungen von Extremwettersituationen (Schocks) sowie der fortlaufenden Umweltzerstörung in der Mekong Region, geraten diese Einkommensquellen jedoch zunehmend unter Druck. Insbesondere die landwirtschaftliche Produktivität und die direkt damit im Zusammenhang stehende Ernährungssicherung und das Wohlergehen der Menschen sind gefährdet. Deswegen ist es wichtig zu untersuchen, wie Haushalte mit diesen Veränderungen umgehen und welche Strategien genutzt werden können, um die Vulnerabilität dieser Haushalte zu reduzieren.

Die oben genannten externen Faktoren tragen maßgeblich dazu bei, dass Haushalte ihre Lebensgrundlagen überdenken müssen. Darüber hinaus sind auch haushaltsinterne Mechanismen entscheidend für die ökonomische Entwicklung, insbesondere die Verhandlungspositionen der einzelnen Haushaltsmitglieder sowie die daraus resultierende Verteilung der Ressourcen. Diese Ressourcenverteilung ist vor allem deswegen von Bedeutung, weil z.B. die richtige Ernährung, Betreuung und Bildung das zukünftige Leistungsvermögen von Individuen maßgeblich beeinflusst und somit die Ressourcenverteilung langfristig einen Einfluss auf die Einkommenssituation hat. Daher ist es wichtig zu verstehen, wie die Ressourcen innerhalb der Haushalte verteilt werden und welche Rolle die Verhandlungsposition der Frau in diesem Zusammenhang spielt.

Ziel der vorliegenden Dissertation ist es, sowohl die äußeren Faktoren, unter denen Haushalte Entscheidungen bezüglich ihrer Lebensgrundlage treffen, als auch die internen Faktoren in Bezug auf die Ressourcenverteilung innerhalb eines Haushalts zu untersuchen. Die in dieser Dissertation behandelten Themen umfassen: (i) das Verhältnis zwischen der Verhandlungsposition der Frau und den Bildungsinvestitionen der Haushalte, (ii) den Zusammenhang zwischen der Ernährungssituation des Haushalts und der Unterernährung einzelner

Haushaltsmitglieder, (iii) den Einfluss von Schocks auf den Vermögensaufbau in ländlichen Regionen, (iv) die Ernährungssituation ländlicher Haushalte vor dem Hintergrund ihrer Lebensumstände, (v) die Bedeutung natürlicher Ressourcen für die Ernährungssicherung und (vi) die Rolle des Einkommes aus dem Abbau natürlicher Ressourcen für das Wohlergehen ländlicher Haushalte.

Die Dissertation ist in sieben Kapitel untergliedert und nutzt Haushaltspaneldaten aus den vier südostasiatischen Ländern Kambodscha, Laos, Thailand und Vietnam. Die kambodschanischen und laotischen Daten basieren auf zwei Befragungswellen aus den Jahren 2013 und 2014. Die Daten für Thailand und Vietnam bestehen aus vier Befragungen, die im Zeitraum von 2007 bis 2013 erhoben wurden. Die zugrundeliegenden Datensätze umfassen somit ländliche Haushalte aus verschiedenen Gebieten der Mekong Region, deren Lebensgrundlagen zum Großteil aus Ackerbau, Viehzucht und Fischfang bestehen. Die einzelnen Kapitel bestehen sowohl aus Einzelfallstudien als auch aus länderübergreifenden Analysen. Die Kapitel 2, 5, 6 und 7 sind Einzelfallstudien, die sich auf Vietnam bzw. Kambodscha beziehen. Kapitel 3 und 4 nutzen Daten aus mehreren Ländern und vergleichen diese.

In Kapitel 2 und 3 werden haushaltsinterne Faktoren analysiert, wobei der Fokus auf den Verhandlungen zwischen den Haushaltsmitgliedern und der daraus entstehenden Ressourcenverteilung liegt. Das 2. Kapitel befasst sich speziell mit der Rolle und der Position der Frau innerhalb des Haushalts und ihren Auswirkungen auf die Bildungsausgaben in Vietnam. Basierend auf der Literatur werden zwei verschiedene Herangehensweisen genutzt, um die Position der Frau abzubilden. Diese wird zum einen durch den Einkommensanteil der Frau im Verhältnis zum Gesamteinkommen des Haushalts gemessen und zum anderen durch ihre Einflussnahme auf wichtige finanzielle Entscheidungen. In der Analyse werden Fixed-Effects, First-Difference und Instrumental-Variables Regressionen angewendet. Die Ergebnisse zeigen, dass Haushalte, in denen Frauen einen größeren Anteil zum Einkommen beitragen, höhere Bildungsausgaben haben. Diese Resultate bestätigen sich auch für die alternative Schätzmethode.

In Kapitel 3 wird untersucht, in wieweit die Indikatoren, welche die generelle Ernährungssituation eines Haushalts abbilden, in der Lage sind, die Unterernährung einzelner Haushaltsmitglieder, speziell von Kindern, anzuzeigen. Auf konzeptioneller Ebene werden hier die Determinanten der Ernährungssicherung mit den Gründen für individuelle Unterernährung verbunden. Das empirische Modell wird auf der Basis eines zweijährigen Paneldatensatzes

aus Kambodscha und Laos, der individuelle Daten von Kindern sowie Haushaltsdaten umfasst, anhand der Methode der kleinsten Fehlerquadrate (Ordinary Least Squares) und einer konditionalen multivariaten Regression geschätzt. Die Analyse zeigt, dass Unterernährung primär mit spezifischen Merkmalen von Müttern und Kindern im Zusammenhang stehen, wohingegen haushaltsspezifische Eigenschaften nur eine untergeordnete Rolle spielen.

In den Kapiteln 4 bis 7 wird der Einfluss der externen Faktoren, insbesondere das Auftreten von extremen Wettersituationen und das Schwinden natürlicher Ressourcen, auf die Lebensgrundlagen und Einkommensquellen ländlicher Haushalte betrachtet. Im 4. Kapitel werden Daten aus allen vier Ländern genutzt, um den Effekt von Schocks auf die Einkommenskapazität zu quantifizieren und generelle regionale, landes- sowie gruppenspezifische Unterschiede aufzuzeigen. Die Analyse besteht aus zwei Teilen: Zuerst wird die Einkommenskapazität der Haushalte basierend auf ihren Vermögensgegenständen in einer Regression geschätzt. Darauf aufbauend wird der Effekt von Schocks auf den prognostizierten Vermögenszuwachs analysiert. Die Ergebnisse zeigen substantielle Unterschiede, sowohl zwischen den einzelnen Einkommensgruppen, als auch den Ländern.

Kapitel 5 und 6 befassen sich mit der Ernährungssituation im ländlichen Kambodscha vor dem Hintergrund abnehmender Fischbestände. Das aus der Literatur bekannte Konzept der nachhaltigen Lebensgrundlagen (Sustainable Livelihood Framework) wird um die Beziehung zwischen einzelnen Einkommenstypen (hier Bargeld und Naturalien) und deren Auswirkung auf die Ernährungssicherung erweitert. Die empirische Analyse unterstreicht die Bedeutung von Fischfang für die Ernährungssicherung im ländlichen Kambodscha. Außerdem zeigen die Ergebnisse, dass die Unterernährung von Kindern in Haushalten mit Einkommen aus der Fischerei geringer ausfällt als in Haushalten, die keinen Fischfang betreiben. Obwohl dieser Zusammenhang zunächst positiv ist, bleibt es vor dem Hintergrund zurückgehender Fischbestände in der Mekong Region fraglich, ob die Fischerei auch in Zukunft eine positive Auswirkung auf das Einkommen und den Ernährungsstatus ländlicher Haushalte in Kambodscha haben wird.

Im 7. Kapitel werden die bestehenden Lebensgrundlagen ländlicher Haushalte in Kambodscha, unter besonderer Beachtung der Rolle natürlicher Ressourcen und deren Abbau, identifiziert und analysiert. In der Analyse werden mittels einer Cluster-Analyse Gruppen von Haushalten gebildet, welche ähnliche Lebensgrundlagen haben. Im Anschluss werden durch Regressionsanalysen die Faktoren bestimmt, welche eine bestimmte Lebensgrundlage

begünstigen. Die Ergebnisse zeigen, wie wichtig der Abbau natürlicher Ressourcen für ländliche Haushalte in Kambodscha ist. Gerade ärmere Haushalte greifen auf natürliche Ressourcen zurück, um Einkommensschwankungen auszugleichen. Trotz allem sind arme Haushalte nur in geringem Umfang für die Umweltzerstörung verantwortlich, da sie keinen großflächigen Ressourcenabbau betreiben.

Schlagwörter: Verhandlungsposition der Frau, haushaltsinterne Ressourcenverteilung, Bildung, wirtschaftliche Entwicklung, Ernährungssicherung, Fischfang, Konzept der nachhaltigen Lebensgrundlagen, Einkommen aus natürlichen Ressourcen, Südostasien

Abstract

In the past decades, the Mekong Region in Southeast Asia has experienced a period of substantial economic growth. Since not all parts of the society benefitted from growth in the same way, inequality in the region increased substantially. Consequently, there is a persistent welfare gap between different nations in the region but also between rural and urban areas within the same country. While urban centers, such as Bangkok or Ho Chi Minh City, offer a multitude of economic opportunities, rural households generate their income largely from agriculture and environmental resource extraction activities. However, these two livelihood activities are more and more challenged by the increasing frequency and impact of weather induced shocks and the degradation of natural resources through humans. As a result, household livelihood outcomes such as agricultural productivity, nutrition status and well-being are at risk. Therefore, it is important to understand how households react to these changes and which strategies can support households to reduce vulnerability to poverty.

While external factors clearly pressure household livelihood choices and outcomes, another dimension of development is related to intra-household bargaining and the resulting resource allocation among household members. The resource allocation is crucial as e.g. nutrition, care and education constitute important channels that influence the individual economic prosperity later in life. Therefore, it is essential to understand how resources are allocated within households and what role the bargaining power of individual members plays.

The overall objective of this thesis is to analyze both aspects, namely the interplay between external conditions and households' livelihood choices as well as household behavior with respect to resource allocation. Specifically, the thesis studies the following topics: (i) the relation between female bargaining power and households' investment into education, (ii) the association between household food security and individual undernutrition, (iii) the influence of shocks on households' asset accumulation, (iv) the food security situation in relation to different livelihood activities, (v) the effect of environmental income on household food security, and (vi) the role of environmental resource extraction for household well-being.

The thesis consists of seven chapters and uses household panel data from the four Southeast Asian countries Cambodia, Laos, Thailand, and Vietnam. The data from Cambodia and Laos was collected in 2013 and 2014 and the data from Thailand and Vietnam covers four waves from 2007 to 2013. The data covers different sub-areas of the Mekong Region and

enables country case studies as well as cross-country comparisons in the analysis. Chapters 2, 5, 6 and 7 are country case studies from Vietnam and Cambodia. Chapters 3 and 4 use data from more than one country.

Chapters 2 and 3 analyze household behavior and internal resource allocation. Chapter 2 studies the influence of female bargaining power on households' investment into education in Vietnam. Using two different approaches to measure female bargaining power, the findings show that both, higher female labor income and financial decision-making, increase households' education expenditures. The analysis is based on four year panel data and employs household fixed-effects, first difference and instrumental variables regressions. The results confirm the positive impact of higher female labor income on households' education expenditures. Furthermore, female power in financial decision-making has a similar effect.

Chapter 3 examines the relation between household-level food security and individual child undernutrition. Conceptually, it combines the determinants of food security with the causes of individual undernutrition. Using two-year child and household-level data from Cambodia and Laos, the empirical model applies Ordinary Least Squares (OLS) and conditional multivariate regression techniques. The results suggest that individual undernutrition in children is largely driven by child- and mother-specific effects, while household-level factors play a minor role.

Chapters 4 to 7 examine the role of shocks and environmental degradation and their effect on households' livelihoods. Using data from Cambodia, Laos, Thailand, and Vietnam, chapter 4 quantifies the effect of shocks on households' income generating capacity and detects general regional, country and economic group specific patterns. The analysis entails a two-step estimation procedure: First, households' income generating capacity is predicted based on assets. Second, the effect of shocks on asset growth is predicted. The results show considerable differences between economic groups and countries.

Chapters 5 and 6 investigate the food security situation of Cambodian households against the background of declining fish stocks. Conceptually, the well-known Sustainable Livelihood Framework (SLF) is extended by explicitly modeling the relationship between different forms of income (cash and in-kind) and household food security. The results underline the importance of fishing for food security in rural Cambodia. In addition, child undernutrition is lower in households that engage in fishing activities. While these effects are positive,

it remains questionable how this will develop in the future as fish stocks are predicted to decline.

Chapter 7 identifies livelihood strategies of farm households in rural Cambodia and explores in how far households depend on environmental resources. The empirical model uses an activity-based two-step cluster analysis to identify livelihood strategies and regression models to determine the factors which influence the choice of livelihood strategies. The findings demonstrate that environmental resources contribute a significant proportion to household income and act as a buffer to reduce income inequality. Furthermore, the results show that poorer households are not to be blamed for environmental degradation as they are unable to undertake high-return activities.

Key words: Female bargaining power, Intra-household resource allocation, Education, Economic development, Food Security, Small-scale capture fishery, Sustainable Livelihood Framework, Environmental income, Southeast Asia

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List of Abbreviations

AEL	Ausschuss für Entwicklungsländer
ASAE	Asian Society of Agricultural Economists
ATE	Average treatment effect
BMI	Body Mass Index
CARD	Council for Agricultural and Rural Development
CDRI	Cambodia Development Resource Institute
CIA	Central Intelligence Agency
DFG	Deutsche Forschungsgemeinschaft
e.g.	(lat. exempli gratia) for example
EAAE	European Association of Agricultural Economists
EUDN	European Development Network
FAO	Food and Agricultural Organization
FCND	Food Consumption and Nutrition Division
FCS	Food Consumption Score
GDP	Gross Domestic Product
GLAD	Globalization and Development
HEP	Hannover Economic Papers
HFIAS	Household Food Insecurity Access Scale
i.e.	(lat. id est) in other words
ICABR	International Consortium on Applied Bio-economy Research
IFPRI	International Food Policy Research Institute
IV	Instrumental Variables
KNOMAD	Knowledge Partnership on Migration and Development
LATE	Local average treatment effect
MDG	Millennium Development Goal
MIT	Massachusetts Institute of Technology
ML	Maximum Likelihood
NBER	National Bureau of Economic Research
NCCD	National Committee for Sub-National Democratic Development
NIS	National Institute of Statistics
NOAA	National Oceanic and Atmospheric Administration
OLS	Ordinary Least Squares
pc	per capita
PCA	Principal Component Analysis
PDR	Peoples Democratic Republic
pp	pages
PPP	Purchasing Power Parity
PPS	proportional to size
PROGRESA	Programa de Educación, Salud y Alimentación
(r)CSI	(reduced) Coping Strategies Index
SD	Standard deviation
SDG	Sustainable Development Goal
SLF	Sustainable Livelihood Framework
TLU	Tropical Livestock Unit
TVSEP	Thailand Vietnam Socio Economic Panel
UK	United Kingdom
UN	United Nations
UNICEF	United Nations Children's Fund
USA	United Stated of America
USAID	United States Agency for International Development
USD	US Dollar
VIF	Variance Inflation Factor
WCED	World Commission on Environment and Development
WFP	World Food Program
WHO	World Health Organization
z.B.	zum Beispiel
ZEF	Center for Development Research, University of Bonn

Chapter 1

Introduction

1.1 Background of the study

In the last decade the Mekong Region has made remarkable progress in reducing poverty. Overall, less than 3% of the population were classified as extremely poor in 2015 (World Bank, 2018). This decrease was largely driven by economic growth in the region (World Bank, 2018). However, despite the overall economic growth, pockets of poverty persist – especially in rural areas (Amare and Hohfeld, 2016; UN, 2015; World Bank, 2012). Consequently, there is a growing welfare gap between different countries in the region but also between rural and urban areas within one country. While households migrate to urban centers, such as Bangkok or Ho Chi Minh City, to increase their income earning opportunities, households in rural areas still largely generate their income from agriculture and environmental resource extraction activities (Parvathi and Nguyen, 2018; Alix-Garcia et al., 2015; Angelsen et al., 2014).

Both livelihoods, agricultural production and environmental resource extraction, are subject to different kinds of shocks which lead to income volatility. The frequency and impact of weather shocks, especially droughts, floods and storms, have increased in recent years (Gloede et al., 2015; Jha and Stanton-Geddes, 2013; World Bank, 2012). As a result, rural households which rely on farming and environmental resources have a higher likelihood of remaining poor or vulnerable, since shocks can push them back into poverty at any time. Therefore, it is important to identify which livelihood strategies should be promoted and what assistance is needed to support households in leaving poverty permanently.

The degradation of natural resources through humankind adds to the livelihood stress faced by rural households. Empirical evidence suggests that the fish stocks of the Mekong and its tributaries are declining due to pollution, construction of dams along the Mekong and overfishing driven by an increasing population, improved fishing technologies and illegal fishing practices (Baran and Myschowoda, 2009; Baran et al., 2007; Hori et al., 2006; Hortle et al., 2004; Navy and Bhattarai, 2009; Orr et al., 2012; Roberts and Baird, 1995). Recent events such as the burst of the Xe Namnoy Dam in Laos (Pearson and Woncha-um, 2018) and mass fish deaths at the Vietnamese central coast as a result of toxic waste water pollution from a local steel plant (Nguyen, 2016; The Guardian, 2016) are just a few examples of how vulnerable the environment is to human interventions. For households in the region, fish is a main source of protein and micro-nutrients (Bezerra da Costa et al., 2014; Dey et al., 2005; Kawarazuka and Béné, 2010). The depletion of fish stocks through overfishing, the construction of dams and industry expansion threatens this livelihood activity and affects households' dietary choices. As a result, households find it increasingly difficult to meet their dietary needs which results in food and nutrition insecurity.

Besides the external factors that influence households' livelihoods, decision-making and resource allocation within the household are also important factors for development. The two main theoretical models which explain household bargaining are the common preference model (Becker, 1974; Samuelson, 1956) and the cooperative household bargaining model (Chiappori, 1997; Thomas, 1990). In the former one household members are assumed to maximize welfare jointly, while in the latter individual household members act as agents who bargain with each other. The empirical evidence on intra-household resource allocation (e.g. Duflo, 2003; Lundberg et al., 1997) largely rejects the common preference model. Instead, the household-level decisions that are observed in many surveys are in fact a result of intra-household bargaining. Given that expenditures on e.g. nutrition, care, and education are decisive for economic prosperity later in life (Basu and Tzannatos, 2003; Duflo, 2003; Lundberg et al., 1997; Rosenzweig, 1990), it is important to increase our understanding of the mechanisms related to intra-household decision-making and resource allocation. Female empowerment is one main channel to change intra-household resource allocation in favour of women and children (Hoddinott and Haddad, 1995; Thomas, 1990; Fafchamps et al., 2009).

Against this background, the overall objectives of this thesis are to understand (i) how internal household decision-making shapes households resource allocation and (ii) how house-

holds' livelihoods change under the pressure of shocks and environmental degradation. Therewith, the thesis looks at two different aspects which shape households livelihood outcomes. On the one hand, it studies the internal behavior of households and on the other hand, it analyzes external factors which influence the conditions under which households make livelihood choices. With respect to the latter, the thesis also investigates how different subgroups of households react to weather related shocks and the degradation of natural resources. The chapters of the thesis can be broadly assigned to those two areas: (i) Chapters 2 and 3 analyze intra-household decision-making and resource allocation, and (ii) Chapters 4 to 7 study household livelihood choices in the light of shocks and environmental resource depletion. The chapters on intra-household decision-making specifically investigate the role of female bargaining power in relation to education and determine whether household-level indicators can predict individual undernutrition. The chapters on household livelihood choices address the effect of shocks on household asset accumulation, analyze the food security situation of households against the background of declining fish stocks and investigate the importance of environmental resource extraction for rural households.

The data used in this thesis is part of the Thailand and Vietnam Socio Economic Panel (TVSEP)[1] and two additional household surveys conducted in Cambodia and Laos. The Thai and Vietnamese sample cover 4,000 rural households in the Thai provinces Buriram, Nakhon Panom and Ubon and the Vietnamese provinces Dak Lak, Ha Tinh and Thua Thien Hue. The panel includes four waves and covers the years 2007, 2008, 2010, and 2013. The Cambodian and Laotian sample consists of 1,200 rural households in the provinces of Stung Treng and Savannakhet. The data collection took place in 2013 and 2014. Together, the data sets cover a variety of areas along the Mekong and allow to compare relatively developed areas such as the Thai provinces Buriram, Nakhon Panom and Ubon, with their poorer neighbors in Cambodia and Laos. While the Vietnamese provinces Ha Tinh and Thua Thien Hue strictly speaking are not part of the Mekong Region, the livelihood and environmental circumstances are very similar to the other provinces and therefore, the results are considered meaningful for households in the region.

The structure of the thesis is as follows: Chapter 1 provides an introduction to the overall research topic and gives an overview of the research questions studied in each chapter. Each of

[1]For more information please visit the project webpage: https://www.tvsep.de/overview-tvsep.html.

the subsequent chapters (Chapters 2 to 7) addresses its own set of research questions, explains the general concept for the analysis, reviews relevant literature, provides an introduction to the data used, displays and discusses relevant empirical results, and formulates suggestions for policy makers.

1.2 Research objectives and contribution to the literature

The thesis consists of six papers which are presented in Chapters 2 to 7. Data-wise the chapters use a mix of country case studies and comparison studies. Chapter 2 is a country case study from Vietnam. Chapter 3 compares Cambodia and Laos. Chapter 4 uses data from all four countries, Cambodia, Laos, Thailand, and Vietnam. Chapters 5 to 7 focus on the Cambodian data. The following paragraphs shortly introduce the research objectives and the contribution to the literature of each chapter. Table 1.1 gives an overview of the chapters and provides information about the publication status, earlier versions and presentations. The contribution of the author to the individual chapters are noted below the table.

Chapter 2 investigates the effect of fluctuations in female labor income on household's resource allocation in relation to child schooling in rural Vietnam. The research questions in this paper are:

1. Does female labor income change households' education expenditures?
2. How sensitive are these results to different measures of female bargaining power?

The chapter contributes to the existing literature on intra-household resource allocation and female bargaining power as it provides evidence for the link between female income and households' education expenditure. In addition, it combines two different approaches of measuring female bargaining power and validates the assumption that the results are consistent across both approaches.

Chapter 3 examines the relation between household food security and individual undernutrition in Cambodia and Laos. Specifically, the paper addresses the following research questions:

1. What is the relation between socio-economic household characteristics and different food security indicators?

2. Do household-level food security indicators predict individual undernutrition?
3. What is the role of mother- and child-specific characteristics for individual undernutrition in children?

The chapter links household and individual-level data and discusses the relation between determinants of food security and the causes of undernutrition. Evidence on the relation between household-level indicators and individual undernutrition is scarce, as health and household surveys are often not compatible (Cafiero, 2013; Carletto et al., 2013). Furthermore, existing papers focus only on the relation between household-level indicators and their ability to predict household-level food security (de Haen et al., 2011; Headey and Ecker, 2013; Maxwell et al., 2014). Therewith, the chapter adds to the existing literature in two ways: First, it links household-level food security and individual undernutrition to household and individual-characteristics. Second, it uses household-level food security to predict undernutrition in individuals.

Chapter 4 uses an asset-based approach of households' income generating capacity to quantify the effect of different shocks on household asset growth. It uses data from four different countries which allows to compare country as well as region-specific patterns. The paper poses the subsequent research questions:

1. How do households with and without shocks move between income quartiles?
2. What is the impact of different shocks on households' income generating capacity?
3. What are general region-specific and country-specific patterns for households in similar economic classes?

This chapter adds to the literature on vulnerability to poverty and quantifies the effect of floods, droughts and illnesses on households' asset accumulation. In addition, it analyzes how households in similar economic groups are affected across the region while controlling for the likelihood to experience a shock. Furthermore, the paper investigates, if households are able to anticipate the risk of experiencing a shock and in how far this shapes their adaptability.

Chapter 5 assesses the food security situation in rural Cambodia in relation to fishing. The research questions in this paper are:

1. How much do fishing activities influence the diets of fishing households in comparison to non-fishing households?

2. Is fish of greater importance for the food security of poorer fishing households than others?

3. What are the other typical income-earning strategies of households that fish?

4. How can these strategies be characterized?

Against the background of declining fish stocks in the Mekong, this chapter quantifies the effects of fishing activities on fish consumption, nutrition and food security for rural households. In addition, the hypothesis whether poorer fishing households rely most on fish in terms of food security and nutrients is tested. This paper adds to the existing literature on fish and food security (Bezerra da Costa et al., 2014; Dey et al., 2005; Lam et al., 2012; Ziv et al., 2012) by exploring the importance of fish for different types of households, namely fishing- and non-fishing households and the poorest income quartile. Therewith, the paper increases our understanding of who will be most affected by the predicted changes in the Mekong River's ecosystem and how wide the potential nutrition gap is which needs to be substituted if fishing income declines.

Chapter 6 directly relates to chapter 5 and expands the analysis. It examines the effects of environmental income derived from small-scale capture fishery on household food security in Cambodia. The detailed research questions in this paper are:

1. What is the effect of in-kind (cash) income from fishing on household food consumption?

2. Which livelihood activities complement and which substitute fishing, income-wise?

3. Is there a connection between income from capture fishery and child anthropometrics?

4. Does the statistical effect of fishing vary across the income distribution?

Conceptually, the chapter extends the Sustainable Livelihood Framework (SLF) to depict the complex relation between rural livelihood choices and food security. The paper adds to the existing literature on fishing and food security in several ways: (i) it considers protein

and calorie intake along with anthropometric data and sheds light on the four dimensions of food security, (ii) it depicts the relationship between in-kind and cash income from fishing while controlling for all other livelihood activities, and (iii) it tests the hypothesis of Aiga et al. (2009) that fishing does not only affect food security through fish consumption per se but also through cash income from sales.

Chapter 7 focuses on environmental resource extraction as part of households' livelihood strategies in rural Cambodia and explores the determinants of environmental resource dependence. The paper addresses the following research questions:

1. What are the livelihood strategies of rural households and how are they determined?
2. How much is the environmental income and how is it distributed?
3. What are the determinants of environmental resource extraction?

This chapter contributes to the literature on livelihood strategy choices and the role of environmental resources for rural households. It is the first paper that assesses the effect of environmental resources on household welfare in Cambodia. In addition, the paper provides evidence for the relation between livelihood choices and environmental resource dependence.

Table 1.1: List of articles included in the thesis

No.	Name of the article	Authors	Published in/ Submitted to/ Presented at
2	Mother's money, child's opportunity: Evidence from intra-household allocation in Vietnam	Dorothee Bühler, Ulrike Grote	Submitted to: *Journal of Development Economics* Earlier version presented at: 1) Annual conference "Development Economics and Policy", Ausschuss für Entwicklungsländer (AEL), Verein für Sozialpolitik, ETH and Zürich University, June 28-29, 2018. 2) International Conference on Globalization and Development (GLAD), Göttingen University, May 3-4, 2018. 3) 16th PhD Workshop on Development Economics, European Development Network (EUDN), Wageningen University, October 26-27, 2017.

Table 1.1 – continued from previous page

No.	Name of the article	Authors	Published in/ Submitted to/ Presented at
			4) Annual conference "Development Economics and Policy", Ausschuss für Entwicklungsländer (AEL), Verein für Sozialpolitik, Heidelberg University, June 28-29, 2016. 5) 6th PhD Workshop, European Association of Agricultural Economists (EAAE), Rome, June 8-10, 2015.
3	Matching food security and malnutrition indicators: Evidence from Southeast Asia	Dorothee Bühler, Rebecca Hartje, Ulrike Grote	Published in: *Agricultural Economics* (2018). 48, 481-495. Earlier version published as: Bühler, D., R. Hartje, and U. Grote (2017). Can household-level food security predict individual undernutrition? Evidence from Cambodia and Lao PDR. *Hannover Economic Papers (HEP)* No. 549, School of Economics and Management. Bühler, D., R. Hartje, and U. Grote (2016). Don't forget about the Children. Latent Food Insecurity in Rural Cambodia. *Agricultural Economics Society*, Conference Proceedings. http://purl.umn.edu/236333 Earlier version presented at: 1) Annual conference "Development Economics and Policy", Ausschuss für Entwicklungsländer (AEL), Verein für Sozialpolitik, Göttingen University, June 1-2, 2017. 2) 3rd Global Food Symposium Göttingen University, April 28-29, 2017. 3) Annual Agricultural Economics Society Conference, Warwick University, April 4-6, 2016. 4) Tropentag, Humboldt University Berlin, September 16-18, 2015.
4	Shocks, vulnerability and income generating capacity of rural households: Evidence from Southeast Asia	Dorothee Bühler, Wendy Cunningham	Published in: *TVSEP Working Paper* (2018). WP-010. Earlier versions presented at: 1) International Consortium on Applied Bioeconomy Research (ICABR), World Bank, Washington DC, June 12-15, 2018. 2) PhD Workshop "Development Economics and Policy", Ausschuss für Entwicklungsländer (AEL), Verein für Sozialpolitik, Hannover University, July 27-28, 2017. 3) 9th Asian Society of Agricultural Economists

Table 1.1 – continued from previous page

No.	Name of the article	Authors	Published in/ Submitted to/ Presented at
			(ASAE) International Conference, Kasetsart University, Bangkok, January 10-14, 2017. 4) PEGnet Conference in Kigali, Rwanda, September 15-16, 2016.
5	Food Security in Rural Cambodia and Fishing in the Mekong in the Light of Declining Fish Stocks	Rebecca Hartje, Dorothee Bühler Ulrike Grote	Published in: *World Food Policy* (2016). 2(2)/3(1), 5-31.
6	Eat Your Fish and Sell It, Too - Livelihood Choices of Small-Scale Fishers in Rural Cambodial	Rebecca Hartje Dorothee Bühler, Ulrike Grote	Published in: *Ecological Economics* (2018). 154, 88-98.
7	Rural Livelihoods and Environmental Resource Dependence in Cambodia	Thanh T. Nguyen, Lam T. Do, Dorothee Bühler, Rebecca Hartje, Ulrike Grote	Published in: *Ecological Economics* (2015). 120, 282-295.

The Author's contributions to the chapters are as follows: Chapter 2 was mainly developed, researched and written by the author with contributions by Ulrike Grote. Chapter 3 was developed jointly with Rebecca Hartje and Ulrike Grote. The author performed the analysis and wrote the paper. Chapter 4 was mainly developed, researched and written by the author with contributions by Wendy Cunningham. Chapter 5 and 6 were developed jointly with Rebecca Hartje and Ulrike Grote. The author provided the analysis of the anthropometrics used in chapters 5 and 6. In addition, the author wrote the paragraphs on the construction of the anthropometrics as well as food security indicators in chapters 5 and 6. Furthermore, the author has supported the development of the conceptual framework used in chapter 6 and supported the peer review process as well as proof-read several versions of the paper. Chapter 7 is joint work with Thanh T. Nguyen, Lam T. Do, Rebecca Hartje, and Ulrike Grote. The author supported the Principal Component and Cluster Analysis used in the econometric analysis. In addition, the author gave comments at several stages of the writing process and proof-read the final draft. Jointly with Rebecca Hartje the author collected and cleaned the data from Cambodia and Laos which are used in Chapters 3-7.

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Chapter 2

Mother's money, child's opportunity: Evidence from intra-household decision-making in Vietnam

This chapter is submitted to:

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Abstract

This paper estimate the effect of female bargaining power on intra-household resource allocation. Using panel data from the Thailand and Vietnam Socio Economic Panel (TVSEP), we address the questions whether (i) female labor income changes households' education expenditures and (ii) how sensitive these findings are to the measurement of female bargaining power. First, we estimate the effect of relative female income on household's education expenditures. Second, we compare the results to a different measure of female bargaining power which is based on a survey measure of financial decision-making. We address the potential endogeneity concerns by applying a mix of fixed-effects and instrumental variables estimations. Our findings suggest that a one standard deviation increase in relative female labor income increases the share of education spending by 8.46 percentage points which is equivalent to 114 PPP USD per year. Further, we find a similar effect if women have more power over financial decision-making. Overall, our results show that households adjust their education expenditure to short-term fluctuations in female labor income. Thus, policies aiming to increase education rates should improve female labor force participation and conditions which strengthen the bargaining position of women.

Key words: Female bargaining power, Intra-household resource allocation, Female labor income, Education, Economic development, Vietnam, TVSEP

JEL classification: D12, D13, I25, J16

2.1 Introduction

Female labor force participation in Southeast Asia has increased up to 56 percent in recent years (ILO, 2012). In Vietnam, about 48 percent of females take part in the labor market (World Bank, 2017). The presence of female labor income changes the income and consumption structure of households. It has been shown that females behave more altruistic towards other family members, especially their children (Duflo, 2003; Fafchamps et al., 2009). If females contribute higher income shares to the household's overall income, their internal bargaining power likely shifts, too. Female bargaining power can change household expenditure towards e.g. nutrition, care and education expenditures which in turn are decisive for economic prosperity of individuals later in live (Basu and Tzannatos, 2003; Duflo, 2003; Rosenzweig, 1990). Therefore, understanding household's resource allocation behavior in relation to gender is essential to guarantee both, gender equality (Sustainable Development Goal 5) and long-term economic growth (Mottaleb et al., 2015). The literature suggests that female household members care relatively more for children and allocate resources accordingly. Thus, an increase in women's labor income (e.g. through transfers or wage income) could indirectly benefit children within the household (Hoddinott and Haddad, 1995; Thomas, 1990).

To date, one main approach to study female bargaining power is to examine the effect of policy changes or natural experiments which redistribute resources to women e.g. through social security payments or asset ownership (Bobonis, 2009; Duflo, 2003; Lundberg and Pollak, 1996; Ponczek, 2011). However, bargaining power within the household does not only change if female household members receive permanent child benefits, pensions, or inherit assets but also if females participate in the labor market and the income composition of the household changes (Dasgupta, 2000). Here, differences in household income are not changed externally but are a result of the internal household bargaining process. However, this literature faces two sources of endogeneity that arise when using the share of female income to estimate female bargaining power (Basu, 2006): (i) reverse causality between female labor income and initial bargaining power as higher bargaining power might allow greater participation in the labor market or vice versa; and (ii) endogeneity of female labor income (and joint household income) in the labor allocation decision of the various household members for any given level of female bargaining power. For this reason, there are only a few

studies which examine the effect of female labor income on household expenditure patterns (for example Qian, 2008; Duflo and Udry, 2004).

Another approach to measure female bargaining power is linked to the psychological literature and uses information on household decision-making (Carlsson et al., 2012; Reggio, 2011). Household decision-making is identified by directly asking respondents about e.g. who is in charge of the major financial decisions in the households. This direct question regarding the households' decision-making circumvents the endogeneity issues outlined above. However, it remains debatable how generalizable these results are to other situations and whether survey questions can portray the complex intra-household bargaining.

In this paper we examine the effect of fluctuations in female labor income on household's resource allocation in relation to child schooling in rural Vietnam. Specifically, the following two research questions are addressed: (i) Does female labor income change households' education expenditures? and (ii) How sensitive are these results to different measures of female bargaining power? We use two different ways to measure bargaining power of females, namely the share of female labor income and control over financial decision-making. Therewith, the paper combines the literature which examines the effect of female labor income on household's resource allocation with the literature which studies the role of financial decision-making for female bargaining power. To the best of our knowledge we are the first ones who provide empirical evidence for both approaches jointly. Using both approaches with the same data allows us to show that the effect is consistent across two very different measurement approaches of female bargaining power.

Our data stems from the Thailand Vietnam Socio Economic Panel (TVSEP). First, we use the share of female labor income to estimate if education expenditures change when women contribute relatively more to the household's income and second, we use control over financial decision-making. The approach is motivated by the fact that female labor force participation in Asia is increasing and higher female income potentially changes the household's internal bargaining. We exploit the panel structure of the dataset and estimate a fixed-effects and first difference equation to address the reverse causality between female labor income and initial bargaining power. In addition, to deal with the endogeneity of female labor income we use an instrumental variables (IV) approach based on exogenous variation in joint agricultural income induced through rainfall. As all rural households in the sample derive a large share of their income from own agricultural production household income is strongly influenced

by rainfall levels. Deviations in rainfall levels are therefore widely used as predictors for agricultural income (Beegle et al., 2006; Deaton, 2010; Grimard and Hamilton, 1999; Jensen, 2000). Second, we use the same dataset to employ an alternative approach where female bargaining power is related to financial decision-making at the household-level. This allows us to verify the results from the first approach and combine two different measures of female bargaining power.

Our results suggest that households adjust their education expenditure to fluctuations in female income shares. The findings from the reduced form and the IV estimation support the baseline outcomes and suggest that a one standard deviation increase in female bargaining power results in 112 to 151 PPP USD higher education expenditures per capita. This finding is supported by similar results from our robustness check, in which we approximate female bargaining power via financial decision-making.

The remainder of the paper is organized as follows: Section 2 discusses relevant literature and introduces our conceptual framework of female bargaining power within the household. Further, different approaches to measure female bargaining power at the household-level are discussed. Section 3 presents the data set and our empirical strategy. Section 4 reports and discusses the results and presents our robustness checks. Finally, Section 5 concludes.

2.2 Literature review and conceptual framework

2.2.1 Household bargaining models

The empirical literature has largely rejected the common preference model where household members are assumed to maximize one joint welfare function (Becker, 1974; Samuelson, 1956). Instead, evidence suggests that internal bargaining is used to reach a decision on household expenditures (Duflo, 2003; Lundberg et al., 1997). Recent field experiments from developing countries found evidence that non-cooperative behavior or partial cooperation is common in the presence of asymmetric information about individual income (Ashraf, 2009; Ashraf et al., 2014; Castilla, 2016).

The theoretical approaches widely applied are based on the cooperative household bargaining model (Chiappori, 1997; Lépine and Strobel, 2013; Lundberg and Pollak, 1996; Maitra, 2004;

Thomas, 1990). Within this theory, the household is not seen as a single decision-making entity but rather as an accumulation of individual agents which bargain to reach a joint decision. Different models regarding the household decision process emerge which are: a) non-cooperative (Ashworth and Ulph, 1981), b) cooperative (McElroy and Horney, 1981), and c) Pareto efficient collective. The former two are difficult to verify as the empirical results depend on the assumptions which were used to determine the bargaining process. As Vermeulen (2002) points out, the empirical rejection does not allow disentangling whether it is due to the choices observed in the data or the underlying bargaining model used. Therefore, this paper follows the Pareto efficient collective model. In its simplest form, the model consists of two agents who use Nash bargaining to reach a solution. The outcome of the bargaining process (in our case household expenditure) depends on the relative power of the respective agent.

The standard theoretical framework aims at modeling the effects of an increase in female labor market income on bargaining power and household expenditures. Similar to Alam (2012) we assume that the households' decision-making process is determined sequentially. In the first stage the household members collaboratively choose how they allocate their labor time to different activities such as own agriculture, wage labor (including off-farm and self-employment), and household chores. Taking these decisions as given, agricultural output and incomes are realized. In the second stage the household decides on expenditures, i.e. consumption, based on the joint utility functions subject to budget constraints. Thus, when the households decide about consumption goods anything that influences income and bargaining power endogenously is already determined in the first stage. Throughout our analysis, we attempt to relax this condition to allow for simultaneous decision on labor participation and expenditures.

Basu (2006) introduces a feedback loop as an additional feature into the model which has been neglected in many empirical studies. This loop allows for feedback between bargaining power and household decision i.e. income shares used as a proxy for bargaining power cannot be seen exogenous to the household decision process. Female labor market participation is part of the household decision and depends on the bargaining powers within the household. Thus, a woman who has little bargaining power has less influence on whether she joins the labor force or not compared to a woman with higher bargaining power. The level of female labor income observed itself depends on the labor leisure decision made by the household.

Many empirical studies use unearned incomes rather than labor incomes to understand the household bargaining process regarding expenditures. Since transfers such as child benefits or family support are based on redistribution policies this allows researchers to concentrate on the second part of the household decision i.e. the expenditure decision only. However, in developing Southeast Asia public social protection spending ranges at 3.3% of GDP which is only half of the average social protection spending in the developing world of 6.3% (ILO, 2016). In addition, a large share of redistribution goes to free access to services or in-kind assistance (such as school feeding) rather than cash transfers (ILO, 2016; World Bank, 2018). Female labor income, on the other hand, has been increasing in recent years along with economic development (ILO, 2012; World Bank, 2017). Therefore, it is important to understand if households change their consumption patterns also in the presence of female labor income.

2.2.2 Female bargaining power

The measurement of female bargaining power is complex, as the actual bargaining process is not directly observed by researchers or covered by survey data. Therefore, empirical researchers have proposed different proxies. In the following we summarize the five major approaches of how to measure female bargaining power within the household. The different measures depend on both the underlying household bargaining model and the data availability.

The first approach focuses on ownership structures and transfers to estimate effects of female bargaining power. This is the theoretically most robust and widely applied option using exogenous changes in unearned income, such as child or family benefits (Lundberg et al., 1997; Rublacava et al., 2009; Braido et al., 2012), asset ownership (Fafchamps et al., 2009; Menon et al., 2014; Wang, 2014), or pensions (Duflo, 2003). The advantages of this approach are that the decision of receiving or increasing transfers or changing asset ownership is not related to the internal bargaining process of the household but is rather induced through a policy change. Thus, the change can be seen as external to the household decision process. However, as the importance of wage income increases concentrating on transfers and asset ownership captures only a part of the behavior.

The second approach attempts to study female bargaining power based on earned income (Alam, 2012; Bertrand et al., 2003; Qian, 2008). While this includes the perspective of how labor income matters for resource allocation, the approach needs to disentangle the more complex effects which arise through the potential feedback between the labor-leisure decision and intra-household bargaining power (Basu, 2006). Due to these identification issues, the existing evidence is limited. The papers by Qian (2008) and Duflo and Udry (2004) are one of the few papers that directly addresses the effect of gender-specific earnings in this context. Based on the unique structure of tea production in China Qian (2008) identifies external variation in female agricultural income. The results show that girl's survival rate and educational attainment of all children increases with higher female income. Duflo and Udry (2004) use the notion of 'gender-specific' crops in West Africa to separate agricultural income for males and females. Their results suggest that households do not pool resources and perfect insurance is not available at the household-level. Some more recent studies investigate the specific cases of female migrant income (Hohfeld, 2014), female off-farm employment (Van den Broeck and Maertens, 2015), and a mix of female income and asset ownership (Masterson, 2012). Other studies do not focus directly on earned income but use related concepts such as the effects of the South African pension program on labor supply and resource allocation within extended families (Bertrand et al., 2003). The findings suggest that the allocation of resources and the labor supply decision of prime age adults depends strongly on age and gender. Studying the effect of gender-specific returns to borrowing on intra-household resource allocation in Bangladesh, Alam (2012) finds that females who receive higher returns to borrowing are able to increase expenditures on child health, clothing, and education.

The third approach predicts female bargaining power through disentangling gender-specific consumption patterns (Bargain et al., 2014; Phipps and Burton, 1998; Masterson, 2012; Tommasi and Wolf, 2016). The identification relies on the assumption that certain goods, e.g. clothing, are separately consumed by gender while other goods are jointly consumed. The existing evidence is quite mixed. The study by Phipps and Burton (1998) rejects the income pooling hypothesis at the household-level for Canadian couples. Increases in child care-related expenditures are triggered by higher female income even when both spouses are in full-time employment. Masterson (2012) finds a pro-male bias in household education spending in Paraguay. However, the effects of female asset ownership on intra-household

resource allocation yield very heterogeneous results in his study. Bargain et al. (2014) and Tommasi and Wolf (2016) explore different methodologies to estimate poverty for men, women, and children separately based on consumption patterns. Their results suggest that men benefit relatively more from welfare programs such as PROGRESA (Tommasi and Wolf, 2016) and that child poverty is underestimated when intra-household resource allocation is ignored (Bargain et al., 2014). While this literature analyses household dynamics, it does not identify bargaining power directly and concentrates on household consumption rather than the effect how bargaining power changes with income streams.

The fourth approach is closely linked to psychology and estimates female bargaining power via a decision-making index (Carlsson et al., 2012; Reggio, 2011). Therewith, using this approach circumvents both the theoretical issue of simultaneity and the data constraints regarding the lack of information on gender disaggregated income or consumption data. The index is either based on answers to different questions regarding decision-making in the household or through introducing an experiment. This allows to look at relative influence of individuals in the decision-making process. Yet, it is not clear whether the results obtained can be generalized to reflect bargaining power in other situations.

Finally, there is a growing number of lab-in-the-field experiments which elicit female bargaining power of spouses via observing individual decisions regarding partner-specific transfers (Beninger and Beblo, 2016; Castilla, 2016; Robinson, 2015) or savings decisions (Ashraf, 2009; Schaner, 2015). In the experiments complete individual and joint consumption patterns are revealed and potential changes in behavior are observed when resource allocations between spouses are varied. Based on these observations an index for relative bargain power is constructed. Evidence suggests, that household members take advantage of asymmetric information and devote higher shares of income to own consumption if the spouse is not aware of the earnings (Ashraf, 2009; Ashraf et al., 2014; Castilla, 2016; Schaner, 2015). Given that experiments take place in an artificial environment, even though they mimic real world situations faced by the participants, and sample sizes are small external validity of the results remains debatable (Deaton and Catwright, 2016). In addition, there is a stark contrast between findings from earlier research where women are found to allocate more resources towards human capital investment of children (Duflo, 2003; Duflo and Udry, 2004) and experimental research which suggests that wives are less cooperative than their husbands (Ashraf, 2009; Castilla, 2016, 2017).

In this paper we use two different approaches to proxy for female bargaining power. First, we follow the second approach and estimate female bargaining power based on labor income. Specifically, we base our estimation on the methodologies proposed by Duflo and Udry (2004) and Qian (2008). Second, to cross-validate our results we also follow the fourth approach and estimate female bargaining power with a decision-making index. Similar to Reggio (2011), we use information on financial decision-making to infer about the bargaining structure within the household.

2.3 Study design

2.3.1 Data and descriptive statistics

The primary data set used is a household panel data set covering three provinces in Vietnam. The survey data is part of a DFG (German Research Foundation) research project on vulnerability to poverty in Thailand and Vietnam. We concentrate on the Vietnamese sub-sample covering four survey waves including 2007, 2008, 2010, and 2013 in Dak Lak, Ha Tinh and Thua Thien Hue (see Figure 2.A.1 in Appendix A). The sample consists of 2,000 rural households engaged in agriculture of which roughly 50% have at least one household member who is engaged in wage employment. The household sample was randomly drawn based on a stratification process considering the heterogeneous agro-ecological conditions within the regions (Hardeweg et al., 2013).[1] In addition, we have access to satellite based rainfall data provided by the National Oceanic and Atmospheric Administration (NOAA). The rainfall data covers daily rainfall from May 2001 to August 2014.

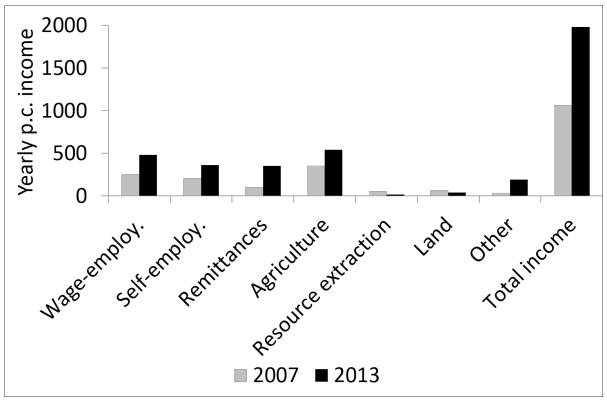
Although the share of females participating in the labor market in Vietnam is growing the share of female wage income is still comparatively small in rural areas. Figure 2.B.2c shows the composition of rural incomes for the DFG panel data set for 2007 and 2013. Overall, incomes from all sources significantly increased between 2007 and 2013. Income from wage and self-employment significantly increased for men and women. The composition of household expenditure for households with and without female employment participation

[1] The researchers employed a three-stage sampling procedure described in detail by Hardeweg et al. (2013). 4,000 household were interviewed in total, 2,000 in Thailand and 2,000 in Vietnam. As a final cluster size ten households were chosen per village.

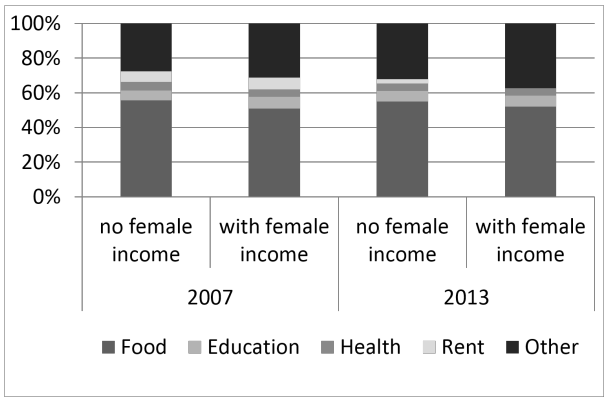
(Figure 2.B.2b) shows that on average households with female labor income do not necessarily spend more of their budget on education. Overall, education expenses account for 8% of household expenditures which equals 109 PPP USD. However, the descriptives do neither control for household-specific effects nor do they allow for a comparison of one household over time.

Figure 2.1: Descriptive statistics

(a) Income sources[a] (per capita per year in PPP USD[+])



(b) Composition of household expenditure by gender



Note: [a]Differences between income sources are significant at the p<0.01 level according to two-sided t-tests except for resource extraction; [+]Purchasing Power Parity US Dollar to base year 2005.
Source: Authors' calculations.

Further, the overall share of households who opt for female wage employment increased from 17 to 24% between 2007 and 2013.[2] On average, females earn considerably less compared to men (see Table 2.1). This wage gap appears to be persistent across all waves. This is largely driven by the types of jobs pursued, which differ by gender. Females tend to work more in the service and food-processing industry while males are involved in the construction industry.

Given the low wages female contribution to the overall household income is also moderate, on average 12% of the household income is earned by women (see Table 2.A.1 in Appendix A) which is equivalent to 1,433 PPP USD. In terms of education females tend to have slightly lower education compared to males. While adult males receive on average 6.8 years of education females reported only 6.13 years of education. Since households with female

[2]The figures are related to the total number of households included in the sample.

labor income differ substantially from households without we focus our analysis only on households with female labor income.[3]

Table 2.1: Wage income by gender

	2017		2013	
Wage income (yearly, at household-level, PPP USD)	Mean	SD	Mean	SD
Male	81.40	166.94	174.89	7.05
Female	34.85	195.47	70.81	4.71
Difference	46.56***	250.68	104.08***	7.94
No. of households	1323		1349	

Note: Wage income excludes income from agricultural services. Significance levels for two sided ttest: *** p<0.01, ** p<0.05, * p<0.1.
Source: Author's calculations.

2.3.2 Baseline specification

To address our research question the analysis is split into three parts. The first part consists of the baseline model which uses a fixed-effects panel regression to assess the impact of female labor income on household education expenditures. Similar to Qian (2008), we use the share of female labor income rather than the absolute amount of income, as specified in equation (2.3). Since a household's decision regarding wage employment has a direct effect on internal bargaining power (Basu, 2006), we need to address the arising endogeneity and reverse causality issue. First, in the baseline specification we use fixed-effects and first difference regressions to solve the reverse causality issue between female labor income and initial bargaining power. In this setting, the fixed-effects control for the initial education level of husbands and wives along with other household time-invariant characteristics. Second, we introduce our instrumental variables (IV) regression to address the endogeneity of female labor income. Third, we perform a series of robustness checks to validate our results.

The baseline regression takes the following form:

$$E_{i,w} = \beta_0 + \beta_1 F_{i,w} + \beta_2 H_{i,w} + \beta_3 Y_{i,w} + \beta_4 D_{i,w} + \gamma_1 h_i + \epsilon_{i,w}, \tag{2.1}$$

[3]We consider any kind of activity reported as self- or off-farm employment by the household, i.e. which is not related to own agriculture, as labor income.

with

$$F_{i,w} = \frac{female\ labor\ income}{total\ household\ income}, \tag{2.2}$$

where $E_{i,w}$ is the share of education expenditures of household i in wave w. $F_{i,w}$ represents the share of female labor income derived from female off-farm and self-employment earnings in relation to overall household income. Contingent on whether the relative income of men or women increases, we expect a change in household education expenditure. Education expenditures are captured at the household-level. In the first step female labor income shares are used as a proxy for bargaining power.

We include a vector of the household structure ($H_{i,w}$), wealth indicators ($Y_{i,w}$), and income generating activities ($D_{i,w}$) to control for further household characteristics that vary across household and time period (see Table 2.A.1 in Appendix A). The vector of household structure differentiates between children, youth, adults, and elderly present in the household.[4] The age cohorts for children and youth were chosen according to the schooling system in Vietnam (Nguyen, 2004). Further, household structure controls include the household size and average female education. Wealth effects are captured by consumption quintiles, the size of land holdings, and assets. The vector of income generating activities controls for different income sources at the household-level such as agricultural production, self-employment, natural resource extraction, and remittances. h_i are household fixed-effects which capture time-invatiant characteristics of each household.

The household fixed-effects regression displayed in equation 2.1 might be problematic as it is based on the assumptions that there is no heteroscedasticity and the error term ($\epsilon_{i,w}$) is serially uncorrelated ($\epsilon_{i,w} : t = 1, 2, \ldots, T$). These assumptions are rather strong and thus, we apply first difference estimation which allows for relaxing them (Wooldridge, 2010).

Therefore, we rewrite the model in first differences as:

$$\Delta E_{i,w} = \beta_1 \Delta F_{i,w} + \beta_2 \Delta H_{i,w} + \beta_3 \Delta Y_{i,w} + \beta_4 \Delta D_{i,w} + \Delta \epsilon_{i,w}, \tag{2.3}$$

[4]We calculate the share of household members from specific age groups as follows: share of children (≥ 6 to ≤ 15 years old), youth (>15 to ≤ 20 years old), adults (>20 to ≤ 60 years old), and elderly (> 60 years old) in the household.

here the underlying assumption is that the first difference of the idiosyncratic errors ($\epsilon_{it} \widehat{=} \Delta\epsilon_{i,w}$, $t = 1, 2, \ldots, T$) are not serially correlated and therewith have a constant variance (Wooldridge, 2010). However, as noted earlier the model might still suffer from endogeneity, especially if the household simultaneously decides about female labor participation and education. In this case, the labor decision and the female bargaining power influence each other resulting in reverse causality. Results from the Hausman and robust Hausman test for fixed-effects (Cameron and Trivedi, 2010) suggest that a fixed-effects model should be preferred over a random-effects model. In order to account for heteroscedasticity and sample selection, cluster robust standard errors are used. The interclass correlation (ρ) for the full fixed-effects panel estimation (see Table 2.A.2, column (2) in Appendix A) indicates that 41% of the variance in the estimation is due to differences across panels. Moreover, the idiosyncratic component of the error term (σ_e) is slightly more important than the individual specific one (σ_u).

2.3.3 IV specification

In the model above, the main concern is reverse causality. As explained in the conceptual framework we assume that the household decides sequentially about the provision of labor and human capital investments. However, bargaining power matters for both decisions. Consequently, female bargaining power influences both the provision of labor and the investment decision.

To address the issue of reverse causality, we use an instrumental variables (IV) approach. Weather and especially rainfall are important determinants of agricultural production. Since the data set covers poor rural Vietnamese households, it appears reasonable to predict income based on weather variability. The main idea is that all agricultural income is subject to fluctuations in rainfall levels. As the agricultural income changes, relative household income earned in off-farm or self-employment activities changes as well. If the share of female labor income can be used as a proxy for internal bargaining power, the household's allocation of resources towards female-favored goods should increase if the share of female labor income rises. Our underlying assumption is that the household determines its labor allocation before the rainfall occurs and does not change it in the course of the time period. This is plausible as households have to decide about the crops planted before or during the planting season

which usually starts before the rainy season. Consequently, also labor supply for self- and wage-employment activities is determined at that point in time.

Duflo and Udry (2004) use a similar approach exploiting the variation in rainfall to predict female and male income from agriculture in Côte d'Ivoire. Contrary to the West African context, agriculture in South East Asia is a joint household activity and crops are not separately farmed by men and women (Lockheed et al., 1980; Jamison and Lau, Jamison and Lau; Quisumbing, 1996). Therefore, our approach differs from Duflo and Udry (2004) as we use the share of female income from off-farm or self-employment activities in relation to total household income. Agricultural income is part of the total household income and enters our main variable of interest in the denominator.

The instrument is constructed from daily precipitation data from 2001 to 2014 provided by NOAA. Following Rosenzweig and Wolpin (1985) we calculate the deviation of rainfall in the critical planting, growing, and harvest season from the long-term average to predict income shares (see Appendix B for details) From the crop data of the household survey we identify rice as the most important crop for households in our sample (see Table 2.B.5 in Appendix B). Previous research with households in our sample confirms the importance of rice farming (Hardeweg et al., 2013). We separate three different seasons where rainfall has a significant impact throughout the two production cycle of rice: (i) the planting period – lasting from November to January and from April to June, (ii) the growing period – months February to March and July, and (iii) the harvest period – lasting from April to May and from August to October (see Figure 2.B.2 in Appendix B). This roughly coincides with the two monsoon seasons in Vietnam which last from November until April and from May until October (Christiaensen et al., 2010). Additionally, the cropping patterns of double-cropped rice in the Mekong Delta with a harvest peak at the end of August (Chen et al., 2012) confirm the patterns observed in the data.

The first stage regression takes the following form:

$$\widehat{F_{i,v,w}} = \pi_0 + \pi_1 DMR_{p,v,w} + \pi_2 H_{i,v,w} + \pi_3 Y_{i,v,w} + \pi_4 D_{i,v,w} + \epsilon_{i,v,w}, \tag{2.4}$$

where i indicates the household and w the survey wave. $DMR_{p,v,w}$ is the demeaned rainfall observed in the respective period (p) at the village-level (v) for the survey year (w). We

include vectors to control for the household structure ($H_{i,v,w}$), household wealth ($Y_{i,v,w}$), and indicator variables for different income earning strategies ($D_{i,v,w}$).

In the second stage we use the predicted female bargaining power to estimate the effect on education expenditure. The second stage regression can be expressed as follows:

$$E_{i,w} = \beta_0 + \beta_1 \widehat{F_{i,w}} + \beta_2 H_{i,w} + \beta_3 Y_{i,w} + \beta_4 D_{i,w} + \epsilon_{i,w}, \tag{2.5}$$

The first stage results, displayed in Table 2.2, indicate that the chosen instrument fulfills the relevance condition. The overall F-statistic well exceeds Stock and Watson's rule of thumb (Stock, 2011) of ten. Thus, the instrumental power is strong, especially for the regression using rainfall in the growing season. Further, the R^2 suggests that rainfall explains about 10 to 13% of the variation of female income shares. The test-statistics for underidentification[5], weak identification[6], and weak instrument-robust inference[7] support the strength of the instrument.

2.3.4 Robustness checks

In order to validate our results we perform three robustness checks. First, since we use the share of female income rather than female income directly we want to rule out that our results are driven by declining or constant male income. Second, we include for total household income as an explanatory variable in all our specifications to test whether we simply observe an income effect. Third, female income might not be the best way to capture female bargaining power.

We address the first concern by reducing our sample to those households where female income remained stable or increased over time. There are several technical ways which lead to an increase in relative female labor income: (i) female income rises and male income falls; (ii) female income rises and there is a proportionally lower increase in male income; (iii) female income falls and male income falls proportionally more; and (iv) female income rises while

[5]In this test H_0 is underidentification, H_1 is identification. The test rejects H_0 at the 7% significance level.

[6]In this test H_0 is weak identification, H_1 is identification.

[7]This test tests the joint significance of endogenous regressors in the main equation, with H_0: all regressors are jointly insignificant and H_1: all regressors are jointly significant.

Table 2.2: First stage

Variables	(1) Female income share	(2) Female income share	(3) Female income share	(4) Female income share	(5) Female income share
Rain planting period	0.0213***			0.0199***	
	(0.0038)			(0.0038)	
Rain growing period		-0.0160***		-0.0108**	
		(0.0045)		(0.0055)	
Rain harvest period			0.0041	-0.0014	
			(0.0045)	(0.0052)	
Rain whole year					0.0057
					(0.0039)
Constant	-0.0022	-0.0887	-0.0825	-0.0113	-0.0774
	(0.0554)	(0.0542)	(0.0544)	(0.0555)	(0.0546)
Controls					
Household structure	x	x	x	x	x
Wealth indicators	x	x	x	x	x
Income sources	x	x	x	x	x
Observations	4,515	4,515	4,515	4,515	4,515
R^2	0.076	0.068	0.065	0.078	0.066
No. of households	1,415	1,415	1,415	1,415	1,415
F-value	12.18	11.45	10.48	11.32	10.63

Note: Cluster robust standard errors in parentheses, clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Household composition controls include: household size, share children, share youth, share adult, share adult old, female headship, education young females, education older females; Wealth indicators include: log productive assets, log unproductive assets, log land size, consumption quintiles; Income sources include: income agriculture (dummy), income self-employment (dummy), income natural resource extraction (dummy), remittances (dummy).
Source: Author's calculations.

male income remains constant. We perform a series of robustness checks in which we test whether the validity of our results holds also for the subsample of households in which (ii) and (iv) or only (ii) has happened.

We address the second concern by including raw household income and the squared from of household income as control variables in all our specifications. This allows us to identify whether the effect of the female income share is driven by an income effect. If the share of female income remains significant and the size of the coefficient remains robust to the inclusion of household income, the effect that we measure is not just a pure income effect.

In order to address the third concern we use an alternative measure to approximate female bargaining power. As mentioned in the literature review, there are a number of studies (Lépine and Strobel, 2013; Maitra, 2004; Reggio, 2011) which address the reverse causality of female bargaining power through a decision-making index. Decision-making is either captured through an experiment or questions which aim to reveal who is involved in crucial decisions. We follow the approach from Reggio (2011) and use a question about financial

decision-making included in the household survey. The questions reveals who is involved in making major financial decisions at the household-level.

Using information about who makes the major financial decisions in the household we adopt a two stage approach introduced by Reggio (2011). In the first step, we estimate female bargaining power at the household-level using distributional factors which affect the power distribution within the household, but do directly relate to individual preferences (see Appendix C for details). Thus, the dependent variable is given by the latent variable which identifies who makes the major financial decisions in the household. In the second step we use the predicted female bargaining power to estimate its impact on the household's share of education expenditure. The method and the results from the first stage are reported in Appendix C. Since the question on financial decision-making was only introduced in 2010, we can only estimate the regression for a subset of the initial panel spanning from 2010 to 2013.

2.4 Empirical analysis

2.4.1 Baseline results

This section presents our baseline results from the fixed-effects panel regression. Column (1) in Table 2.3 shows the results without any control variables and suggests that the correlation between the share of female labor income and household education expenditures is positive and statistically significant at the 10% level. Results in columns (2)-(3) support the positive correlation which persists if the full set of control variables is added. Despite its statistical significance the female income share coefficient indicates that the overall economic effect is rather small. While a causal interpretation is difficult due to endogeneity issues, we refrain from providing an economic interpretation at this stage. Indeed, the coefficient decreases when more control variables are included.

The results in column (3) indicate that female leadership has a positive and significant effect on the share of education expenditure for household with female labor income. For male headed households the interaction effect remains positive but becomes insignificant. This hints at the fact that female bargaining power is higher in female-headed households com-

pared to male-headed households. However, the share of expenditures devoted to education is on average not higher for female-headed households compared to male-headed ones.

Table 2.3: Fixed-effects panel and first difference fixed-effects regression

	Fixed-effects			Fist difference
Variables	(1) Share educ. education exp.	(2) Share education exp.	(3) Share education exp.	(4) Δ Share education exp.
Female income share	0.0129*	0.0107		0.000247***
	(0.00766)	(0.00768)		(5.42e-05)
Female income share *female head=0			0.00795 (0.00888)	
Female income share *female head=1			0.0227* (0.0122)	
Constant	0.0794***	0.0248	0.0241	0.00679***
	(0.000917)	(0.0243)	(0.0243)	(0.00129)
Controls				
Household structure		x	x	x
Wealth indicators		x	x	x
Income sources		x	x	x
Observations	4,515	4,515	4,515	3,267
R^2	0.001	0.045	0.035	0.021
No. of households	1,415	1,415	1,415	1,413
ρ	0.415	0.406	0.405	0.318
σ_e	0.0683	0.0670	0.0670	0.0907
σ_u	0.0575	0.0554	0.0553	0.0619
R^2 within	0.00105	0.0451	0.0452	0.0345
R^2 between	0.000599	0.0708	0.0730	0.0123
R^2 overall	5.70e-07	0.0537	0.0549	0.0228

Note: Robust standard errors in parentheses, standard errors are clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Household composition controls include: household size, share children, share youth, share adult, share adult old, female headship, education young females, education older females; Wealth indicators include: log productive assets, log unproductive assets, log land size, consumption quintiles; Income sources include: income agriculture (dummy), income self-employment (dummy), income natural resource extraction (dummy), remittances (dummy).
Source: Authors' calculations.

The control variables (for full report on results, please refer to Table 2.A.2 in Appendix A), largely show the expected signs. While the household size itself is not statistically significant, the age structure of the household matters. Households with higher shares of children and adolescents, who can potentially attend school, spend relatively more on education. Similarly, if the share of adults is higher the share spent on education is also higher. We believe that this reflects a resource effect based on higher income available. Contrary to our expectation, we do not find an effect of female education on education expenditures. However, part of the education effect is reflected in female labor income itself as higher educated females are more likely to engage in wage employment.

Productive assets have a small but positive and statistically significant effect on the share of education expenditures. Unproductive assets and land size have no significant effect. It seems that productive asset ownership is more important in this context, as it is related to productivity. The indicator variables controlling for consumption quintiles reveal that compared to the households in the highest quintile all other households have a lower share of education expenditures. The effect is statistically stronger for the intermediate quintiles (2 and 3) compared to the poorest quintile. However, the sizes of the coefficients are rather close indicating that only households in the richest quintile are able to devote a higher share of their resources towards education.

The estimation in first differences (column 4) relaxes the assumption that no heteroscedasticity is present and that the errors are serially uncorrelated. The results suggest that not only the share of female labor income but also a change in relative female labor income affects education expenditures. A positive change in relative female labor income results in an increase in the share of household education expenditures. The results confirm our hypothesis that households not only react to long-term increases in female labor income but also to short-term changes in the income composition.

Finally, our results might be driven by stable or declining male incomes as opposed to increasing female incomes. However, when reducing the sample for those households where female income remained stable or increased over time, the results remain largely the same (see Table 2.A.3 in Appendix A). In addition, our results are also robust to including household income (see Table 2.A.4 in Appendix A). Thus, our results do not just capture an income effect of households.

Overall our results suggest that higher relative female labor income has a positive and significant effect on household's education expenditures. Further, households seem to adjust their education expenses also to short-term fluctuations in female labor income.

2.4.2 Instrumental variable results

In this section we present the second stage results of the IV regression. The results in Table 2.4 indicate that higher relative female labor income has a positive and significant effect on the share of education expenditures (see Table 2.B.6 in Appendix B for full report on results). Columns (1) to (3) display the results using rainfall from the planting period as

an instrument. The findings suggest that a higher female income share has a positive and statistically significant effect. If the share of female labor income increases by one standard deviation (0.21) this translates into an 8.46 percentage point increase in relative education expenses. Given that households spend on average 108.70 PPP USD per year on education per capita this equals an increase by 114 to 151 PPP USD.[8] Households need to work between 29 to 38 days to raise this amount of income (see average per capita income per day, Table 2.A.1 in Appendix A). Compared to the fixed-effects panel regression the effect appears to be significantly larger. However, this difference can be explained since the fixed-effects regression gives us the average treatment effect (ATE) whereas the instrumental variables approach only gives us the local average treatment effect (LATE). While the ATE measures the effect of the increase for all households, the LATE measures the average effect on those households in which the share of female income changes through rainfall. We also used the rainfall indicators form all seasons jointly to check the validity of our results (see Table 2.B.6 in Appendix B).

The results from the reduced from (Table 2.4, column 4) confirm the results from the instrumental variables regression. Both, rainfall in the planting and in the growing season have a statistically significant impact of the share of education expenditures, while more rain in the harvest period has a negative effect on education expenses. Given that rainfall has differential effects across seasons it appears reasonable that more rainfall in the planting period increases agricultural output while it can destroy the harvest at a later point in time.

The Kleinbergen-Paap test for underidentification, the weak instrument-robust inference tests based on the Stock and Wright (2000) S statistic and the Anderson and Rubin (1949) test for joint insignificance of the endogenous regressors in the structural equation confirm that the overidentification restriction holds. All three test statistics show that we can reject the null hypothesis of joint insignificance at the first stage and that the overidentification restrictions are valid.

[8]The increase is calculated as: $\beta_1 * 1SD\ share\ female\ income = 0.403 * 21 = 8.46$ percentage points increase in the share of education expenditures. With a mean of 8% of the share of education expenditures this increases the share of education expenditures to 16.46%. The percentage increase in education spending is given by: $\frac{percentage\ point\ increase}{mean\ of\ share\ education\ expenditures}$. Given the mean of 108.70 PPP USD education expenditure per capita this results in an increase by 114.28 to 150.94 PPP USD of education expenditures per capita. Averages and standard deviations for the female income share and education expenditures are reported in Table 2.A.1 in Appendix A.

Table 2.4: Second stage (2SLS, instrument: rain in planting period)

	IV			Reduced form
	(1)	(2)	(3)	(4)
Variables	Share education expenditure	Share education expenditure	Share education expenditure	Share education expenditure
Female income share	0.403***	0.448***	0.529***	
	(0.0684)	(0.101)	(0.120)	
Rain growing period			0.00899**	0.00427*
			(0.00407)	(0.00229)
Rain harvest period			-0.0100***	-0.0129***
			(0.00352)	(0.00183)
Rain planting period				0.0105***
				(0.00139)
Controls				
Household structure		x	x	x
Wealth indicators		x	x	x
Income sources		x	x	x
Instrument	Rain planting	Rain planting	Rain planting	
Observations	4,515	4,515	4,515	4,515
No. of households	1,415	1,415	1,415	1,415
First stage test statistics				
F-value	67.25	30.94	26.91	
χ^{2a}	65.73	29.45	25.87	
p-val[a]	0.000	0.000	0.000	
Kleinbergen-Paap rk F[b]	67.25	30.94	26.91	
Stock-Wright χ^{2c}	59.84	44.27	54.97	
Stock-Wright p-val[c]	0.000	0.000	0.000	
Anderson-Rubin χ^{2d}	65.06	47.09	57.55	
Anderson-Rubin p-val[d]	0.000	0.000	0.000	
Anderson-Rubin F[d]	65.02	46.88	57.27	
Anderson-Rubin p-val[d]	0.000	0.000	0.000	

Note: Cluster robust standard errors in parentheses, clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
[a]Underidentification test based on Kleinbergen-Paap rk LM; [b]weak instrument identification test based on rk F; [c]weak instrument robust inference based on Stock and Wright; [d]weak instrument robust inference based on Anderson and Rubin.
Source: Authors' calculations.

We also test, whether the findings are purely driven by an income effect. However, the results for both the first and the second stage remain largely unchanged when we include household income (see Tables 2.B.7 and 2.B.8 in Appendix B). Thus, our results do not just capture an income effect of households.

2.4.3 Alternative measure of female bargaining power

In this section we want to consider an alternative measures of female bargaining power to justify our results and address the issue of initial female bargaining power separately. The results from the second stage, displayed in Table 2.5, show that female bargaining power measured through financial decision-making at the household-level has a strong and positive effect on the share of education expenditures. If female bargaining power increases by one standard deviation this increases the share of education expenditure by 6 to 8 percentage points. In relation to the average education expenditures of 108.70 PPP USD per year this equals an increase by 79 to 105 PPP USD per year.[9] Households need to work between 20 to 26 days to raise this amount of income (see average per capita income per day, Table 2.A.1 in Appendix A).

Table 2.5: Alternative bargaining power

Variables	(1) Share education expenditure	(2) Share education expenditure
Bargaining power	0.189***	0.141***
	(0.0259)	(0.0284)
Constant	0.0530***	0.0431
	(0.00414)	(0.0446)
Controls		
Household structure		x
Wealth indicators		x
Income sources		x
Observations	1,943	1,943
R^2	0.070	0.097
No. of households	1,187	1,187

Note: Cluster robust standard errors in parentheses, clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations.

[9]The increase is calculated as follows: $\beta_1 * 1SD\ bargaining\ power = 0.189 * 41 = 7.75$ percentage points increase in the share of education expenditures. With a mean of 8% of the share of per capita education expenditures this increases the share of education expenditures to 15.75%. The percentage increase in education spending is given by: $\frac{percentage\ point\ increase}{mean\ of\ share\ education\ expenditures}$. Given the mean of 108.70 PPP USD education expenditure this results in an increase by 78.55 to 105.30 PPP USD of education expenditures.

Overall, the results confirm the positive effect of female bargaining power on education expenditures however. The monetary effect of bargaining power seems to be relatively stable across the IV and the alternative estimation presented. Yet, female bargaining power is a complex issue and measures of intra-household decision-making might be better suited to estimate female bargaining power compared to female labor income.

2.5 Summary and conclusion

This paper sheds light on the relation between female bargaining power and household's resource allocation. Using panel data from Vietnam, we specifically assess (i) if female labor income changes household's education expenditures and (ii) how robust these findings are to using different measures of female bargaining power. Methodologically, we add to the existing literature by combining two approaches of measuring female bargaining power. First, we use exogenous variation in rainfall to estimate the share of female labor income. Second, we apply a two-step procedure to estimate female bargaining power based on financial decision-making.

With respect to the first research question our results suggest that households adjust the share of expenditure spent on education to fluctuations in female labor income. Both, the results from the fixed-effects panel regression and the instrumental variables regression suggest that a higher share of female labor income has a positive and significant effect on the resources devoted to education. The lower bound of the effect is estimated in the baseline regression, which estimates the average treatment effect. It suggests that a one standard deviation increase in relative female labor income increases education expenditures by approximately 4 PPP USD per capita per year. The instrumental variables results estimate the local average treatment effect which we interpret as an upper bound. Consequently, a one standard deviation increase in the share of female labor income translates into an increase in education spending per capita by 114 to 151 PPP USD. Assuming that relative income shares are a feasible proxy for internal bargaining power this shows that female bargaining power within the household changes and bargaining takes place repeatedly.

Concerning the second research question, we find that our results are robust to using a financial decision-making index as an alternative approach to measure female bargaining power. Following an estimation method introduced by Reggio (2011) the results suggest

that a one standard deviation increase in female bargaining power leads to a 78 to 105 PPP USD higher spending on education per capita. While the financial decision-making index does not capture the ongoing labor-leisure decisions taken by the household, the results serve as a benchmark for the labor income estimation.

From a policy perspective these results suggest that encouraging female labor market participation is important and should be further supported to increase female bargaining power. This in turn can increase the resources spent on education and potentially other child related goods as well as food and health expenditures.

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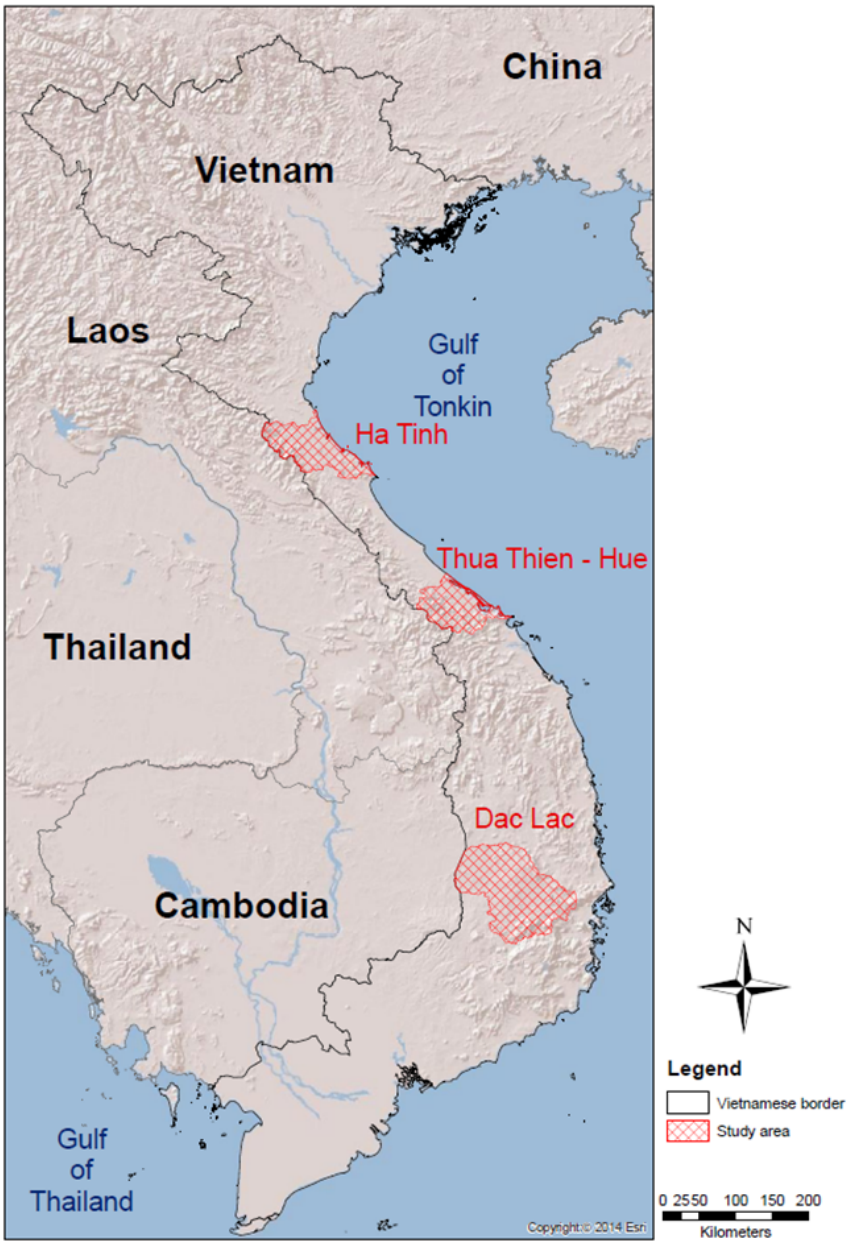
2.A Appendix A

Figure 2.A.1: Survey region in Vietnam



Authors' representation.

Table 2.A.1: Overview main control variables

Variables	Mean	SD
Share female income	0.12	0.21
Female income (PPP USD)	1,433.07	10,884.56
Share education expenditure	0.08	0.07
Education expenditures (PPP USD)	108.69	190.73
Raw income (PPP USD)	7,010.83	24,045.05
Daily income per capita (PPP USD)	3.98	7.71
Household size	4.43	1.99
Share small child (0-5 yr.)	0.06	0.11
Share children (6-15 yr.)	0.27	0.18
Share youth (16-20 yr.)	0.14	0.15
Share adult (21-60 yr.)	0.48	0.15
Share elderly (>61 yr.)	0.05	0.10
Share female head (dummy)	0.11	0.31
Years of education adult females (>21 yr.)	6.13	3.68
Years of education young females (<21 yr.)	0.80	2.05
Years of education adult males (>21 yr.)	6.77	3.87
Years of education young males (<21 yr.)	1.02	2.35
Assets		
Land size (in ha)	1.04	2.64
Productive assets (in PPP USD)	1,770.47	16,629.17
Unproductive assets (in PPP USD)	2,233.28	2,787.19
Consumption quintiles		
Quintile 1	0.28	0.45
Quintile 2	0.23	0.42
Quintile 3	0.20	0.40
Quintile 4	0.17	0.37
Quintile 5	0.12	0.33
Income sources		
Agriculture	0.96	0.21
Self-employment	0.29	0.46
Nat. resource extraction	0.51	0.50
Remittances	0.36	0.48
Observations	4,515	

Source: Authors' calculations.

Table 2.A.2: Fixed-effects panel and first difference regression, full set of control variables

	Fixed-effects			First difference
	(1)	(2)	(3)	(4)
Variables	Share education exp.	Share education exp.	Share education exp.	Δ Share education exp.
Female income share	0.0129*	0.0107		0.0003***
	(0.0077)	(0.0077)		(5.42e-05)
Share child (6-15 yrs)		0.0759***	0.0761***	-0.0197
		(0.0134)	(0.0133)	(0.0174)
Share youth (16-20 yrs)		0.131***	0.131***	0.0243
		(0.0172)	(0.0172)	(0.0244)
Share adult (21-60 yrs)		0.0774***	0.0780***	0.0367
		(0.0218)	(0.0218)	(0.0300)
Share elderly (>60 yrs)		0.148***	0.147***	0.120***
		(0.0402)	(0.0401)	(0.0449)
Female household head		0.0055		-0.0025
		(0.0117)		(0.0163)
Education females (<21 yrs)		-0.0022**	-0.0022**	-0.0007
		(0.0009)	(0.0009)	(0.0009)
Education females (>21 yrs)		-0.0012	-0.0012	-0.0008
		(0.0008)	(0.0008)	(0.0008)
Log assets		0.0015	0.0016	0.0031
		(0.0016)	(0.0016)	(0.0019)
Log land size		0.00011	0.00017	0.0036
		(0.0018)	(0.0018)	(0.0024)
Consumption quintile 1		-0.0171**	-0.0171**	-0.0138*
		(0.0082)	(0.0082)	(0.0082)
Consumption quintile 2		-0.0229***	-0.0229***	-0.0167**
		(0.0077)	(0.0077)	(0.0078)
Consumption quintile 3		-0.0228***	-0.0227***	-0.0194***
		(0.0074)	(0.0074)	(0.0075)
Consumption quintile 4		-0.0118	-0.0118	-0.0143*
		(0.0075)	(0.0075)	(0.0078)
Income agriculture		-0.0064	-0.0059	-0.0013
		(0.0103)	(0.0103)	(0.0113)
Income self-employment		-0.0036	-0.0035	-0.0039
		(0.0046)	(0.0046)	(0.0048)
Income hunting		-0.0166***	-0.0166***	-0.0154***
		(0.0031)	(0.0031)	(0.0032)
Remittances		0.0025	0.0026	-0.0022
		(0.0029)	(0.0029)	(0.0034)
Female income share* female headship=0			0.0079	
			(0.0089)	
Female income share* female headship=1			0.0227*	
			(0.0122)	
Constant	0.0794***	0.0248	0.0241	0.0068***
	(0.0009)	(0.0243)	(0.0243)	(0.0013)
Observations	4,515	4,515	4,515	3,267
R^2	0.001	0.045	0.045	0.034

Note: Cluster robust standard errors in parentheses, clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations.

Table 2.A.3: Fixed-effects panel and first difference regression, reduced sample

	Fixed-effects		First differences
	(1)	(2)	(3)
Variables	Share education exp.	Share education exp.	Δ Share education exp.
Female income share	0.0142*	0.0139*	0.0003***
	(0.0079)	(0.0084)	(6.64e-05)
Constant	0.0752***	-0.0045	0.0117***
	(0.0014)	(0.0305)	(0.0021)
Controls			
Household structure		x	x
Wealth indicators		x	x
Income sources		x	x
Observations	2,833	2,833	1,795
R^2	0.002	0.045	0.052
No. of households	996	996	854
ρ	0.429	0.416	0.351
σ_e	0.0671	0.0660	0.0924
σ_u	0.0582	0.0557	0.0679
R^2 within	0.0021	0.0447	0.0518
R^2 between	4.72e-05	0.0820	3.99e-05
R^2 overall	0.0006	0.0642	0.0180

Note: Robust standard errors in parentheses, standard errors are clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Household composition controls include: household size, share children, share youth, share adult, share adult old, female headship, education young females, education older females; Wealth indicators include: log productive assets, log unproductive assets, log land size, consumption quintiles; Income sources include: income agriculture (dummy), income self-employment (dummy), income natural resource extraction (dummy), remittances (dummy). This regression was run for the subset of the households with rising female income and decreasing male income as well as households with rising female income and constant male income.
Source: Authors' calculations.

Table 2.A.4: Fixed-effects panel and first difference regression with household income

	Fixed-effects		First differences
	(1)	(2)	(3)
Variables	Share education exp.	Share education exp.	Δ Share education exp.
Female income share	0.0165**	0.0134*	
	(0.0077)	(0.0077)	
Income	0.0080	0.0125*	-0.0046
	(0.0069)	(0.0068)	(0.0085)
Income^2	-0.0007	-0.0010**	-3.21e-05
	(0.0004)	(0.0004)	(0.0007)
Constant	0.0612**	-0.0181	-0.0140***
	(0.0279)	(0.0358)	(0.0034)
Controls			
Household structure		x	x
Wealth indicators		x	x
Income sources		x	x
Observations	4,300	4,300	3,012
R^2	0.003	0.051	0.015
No. of households	1,411	1,411	1,369

Note: Robust standard errors in parentheses, standard errors are clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Household composition controls include: household size, share children, share youth, share adult, share adult old, female headship, education young females, education older females; Wealth indicators include: log productive assets, log unproductive assets, log land size, consumption quintiles; Income sources include: income agriculture (dummy), income self-employment (dummy), income natural resource extraction (dummy), remittances (dummy).
Source: Authors' calculations.

2.B Appendix B

Instrument

We construct our instrument, standardized deviation of mean rainfall in the planting, growing, and harvest season based on Rosenzweig and Wolpin (1985) In a first step we calculate the mean and standard deviation of rainfall per season for each survey village. Mathematically, this can be expressed as:

$$AR_{s,v} = \frac{\sum_{i=1}^{t} \vartheta_{s,t,v}}{t} \quad and \quad sd(AR_{s,v}) = \frac{\sum_{i=1}^{N} \vartheta_{s,t,v} - AR}{N-1} \tag{2.6}$$

for all years excluding the survey years (2007, 2008, 2010, 2013). $AR_{s,v}$ is the average rainfall per season (s) in village v. $\vartheta_{s,t,v}$ is the daily rainfall per village and t gives the number of days of the respective season. In addition, we also calculate the average rainfall per village and season for the respective survey as specified in formula 8.

$$AR_{s,v,w}(for\ w = 2007 \mid w = 2008 \mid w = 2010 \mid w = 2013) = \frac{\sum_{i=1}^{t} \vartheta_{s,t,v,w}}{t} \tag{2.7}$$

In a second step we generate the standardized deviation of the rainfall in the seasons for the survey years.

$$R_{s,v,w} = \frac{AR_{s,v,w} - AR_{s,v}}{sd(AR_{s,v})}. \tag{2.8}$$

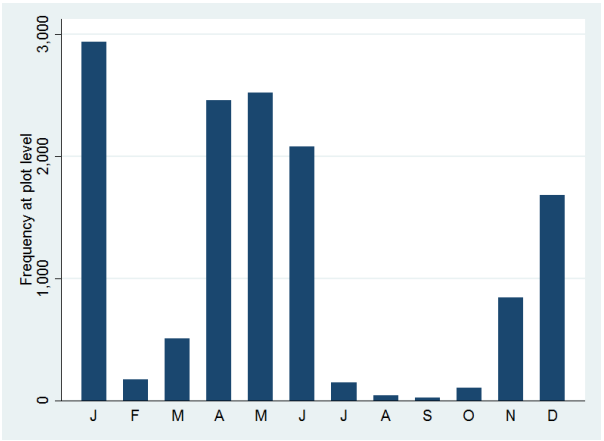
Table 2.B.5: Importance of crops by survey wave

Share of households who produce*:	Survey wave 2007	2008	2010	2013
Rice	73%	73%	74%	70%
Coffee	24%	24%	26%	26%
Fruits	16%	24%	25%	22%
Nuts	22%	26%	24%	25%
Corn	19%	22%	18%	16%
Vegetables	8%	38%	28%	25%

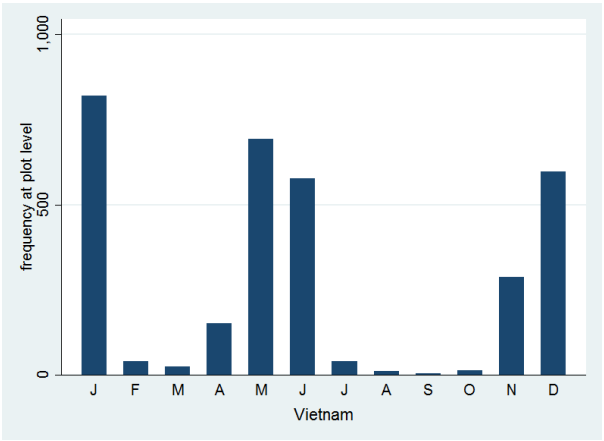
Note: *Households can grow multiple crops.
Source: Authors' calculations.

Figure 2.B.2: Cropping calendar for rice cultivation in survey area

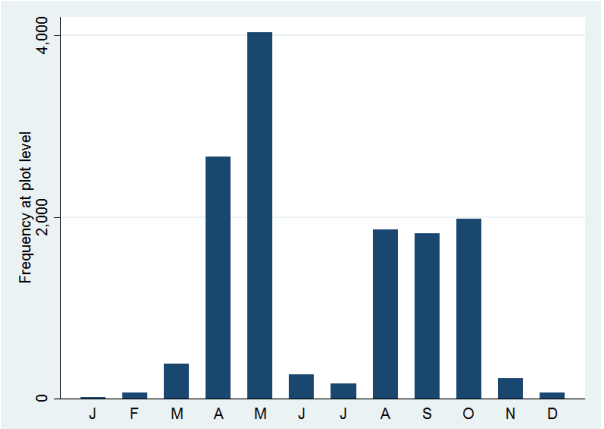
(a) Start of planting period (all survey years)



(b) Start of harvest period (only 2007)



(c) End of harvest period (all survey years)



Source: Authors' calculations.

Table 2.B.6: Instrumental variables regression, full set of controls, different instruments

Variables	(1)[a] Share education expenditure	(2)[b] Share education expenditure	(3)[b] Share education expenditure
Female income share	0.448***	0.350***	0.433***
	(0.101)	(0.0632)	(0.0960)
Share child (6-15 years)	0.0361		0.0375
	(0.0239)		(0.0233)
Share youth (16-20 years)	0.0598*		0.0623**
	(0.0312)		(0.0301)
Share adult (21-60 years)	-0.0192		-0.0157
	(0.0364)		(0.0354)
Share elderly (>60 years)	0.121**		0.122**
	(0.0526)		(0.0517)
Education females (<21 years)	-0.0051***		-0.0049***
	(0.0014)		(0.0014)
Education females (>21 years)	0.0001		5.64e-05
	(0.0012)		(0.0011)
Log assets	0.0096***		0.0093***
	(0.0032)		(0.0031)
Log land size	0.0034		0.0032
	(0.0033)		(0.0032)
Female household head	-0.0437*		-0.0419*
	(0.0232)		(0.0223)
Income agriculture	-0.0034		-0.0035
	(0.0179)		(0.0175)
Income self-employment	-0.0544***		-0.0526***
	(0.0132)		(0.0128)
Income hunting	-0.0140***		-0.0141***
	(0.0042)		(0.0042)
Remittances	0.0057		0.0056
	(0.0041)		(0.0041)
Consumption quintile 1	-0.0145		-0.0146
	(0.0109)		(0.0107)
Consumption quintile 2	-0.0270***		-0.0269***
	(0.0102)		(0.0100)
Consumption quintile 3	-0.0239**		-0.0238**
	(0.0100)		(0.0098)
Consumption quintile 4	-0.00937		-0.0095
	(0.0095)		(0.0096)
Observations	4,515	4,515	4,515
No. of households	1,415	1,415	1,415
Instrument	rain planting	rain all periods	rain all periods
First stage test statistics			
F-value	30.94	23.93	11.37
χ^2	29.45	69.55	32.4
p-value	0.000	0.000	0.000
Kleinbergen-Paap rk F	30.94	23.93	11.37

Note: Cluster robust standard errors in parentheses, clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
[a]Instrument: rainfall in planting period, [b]instrument: rainfall in all periods.
Source: Authors' calculations.

Table 2.B.7: First stage with household income

Variables	(1) Female income share	(2) Female income share	(3) Female income share	(4) Female income share	(5) Female income share
Rain planting period	0.0168***			0.0164***	
	(0.0039)			(0.0039)	
Rain growing period		-0.0018		-0.0006	
		(0.0145)		(0.0144)	
Rain harvest period				-0.0039	
				(0.0059)	
Rain whole year					-0.0027
					(0.0041)
Income	0.0646**	0.0684**	0.0705**	0.0656**	0.0695**
	(0.0279)	(0.0281)	(0.0281)	(0.0278)	(0.0282)
Income^2	-0.0026	-0.0027	-0.0028	-0.0026	-0.0027
	(0.0017)	(0.0019)	(0.0019)	(0.0019)	(0.0019)
Constant	-0.342***	-0.430***	-0.442***	-0.352***	-0.439***
	(0.117)	(0.115)	(0.115)	(0.117)	(0.116)
Controls					
Household structure	x	x	x	x	x
Wealth indicators	x	x	x	x	x
Income sources	x	x	x	x	x
Observations	4,300	4,300	4,300	4,300	4,300
R^2	0.089	0.082	0.083	0.090	0.082
No. of households	1,411	1,411	1,411	1,411	1,411
F-value	14.39	13.85	13.57	13.16	13.57

Note: Cluster robust standard errors in parentheses, clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Household composition controls include: household size, share children, share youth, share adult, share adult old, female headship, education young females, education older females; Wealth indicators include: log productive assets, log unproductive assets, log land size, consumption quintiles; Income sources include: income agriculture (dummy), income self-employment (dummy), income natural resource extraction (dummy), remittances (dummy).
Source: Authors' calculations.

Table 2.B.8: Second stage (2SLS, instrument: rain in planting period) with household income

Variables	(1) Share education expenditure	(2) Share education expenditure	(3) Share education expenditure	(4) Share education expenditure
Female income share	0.658***	0.633***	0.718***	
	(0.131)	(0.139)	(0.191)	
Rain growing			0.0047	0.0033
			(0.0050)	(0.0023)
Rain harvest			-0.0037	-0.0119***
			(0.0052)	(0.0018)
Rain plant				0.0116***
				(0.0015)
Income	-0.0393*	-0.0273	-0.0322	0.0105
	(0.0224)	(0.0215)	(0.0254)	(0.0068)
Income^2	0.0010	0.00045	0.0007	-0.0009**
	(0.0014)	(0.0013)	(0.0015)	(0.0004)
Controls				
Household structure		x	x	x
Wealth indicators		x	x	x
Income sources		x	x	x
Instrument	rain planting	rain planting	rain planting	rain planting
Observations	4,266	4,266	4,266	4,300
No. of households	1,377	1,377	1,377	1,411
Instrument:	rain harvest	rain harvest	rain harvest	
F-value (first stage)	14.39	13.85	13.57	

Note: Cluster robust standard errors in parentheses, clustered at household-level. Significance levels: *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations.

2.C Appendix C

Alternative measure of female bargaining power

Similar to Reggio (2011) we estimate the effect of female bargaining power on education expenditures in two stages. First, we estimate female bargaining power at the household-level, denoted by ϑ. In the second step we estimate the impact of ϑ on the household's share of education expenditure. In the first stage we estimate a logit regression with:

$$\vartheta_{i,w} = \begin{cases} 1 & \text{if the wife decides,} \\ 0 & \text{otherwise.} \end{cases} \tag{2.9}$$

The individual likelihood function for the decision is then given by:

$$Pr(\vartheta_{i,w} = 1) = \mu_1 + \mu_2 Age\_diff + \mu_3 Sex\_ratio + \mu_4 Age\_diff * Sex\_ratio + \mu_5 C + \omega_{i,w}, \tag{2.10}$$

where female bargaining power based on financial decision-making is estimated using suitable distributional factors, that is variables which have affect the power distribution within the household, but do directly relate to individual preferences. Following Reggio (2011), we include the age difference between husband and wife, the sex ratio of males relative to females measured at village-level, and an interaction term between the two factors. Further, the control vector includes the squared age difference and sex ratio as well as husband's and wife's education.

In the second stage we use the estimates from ϑ as the regressors for female bargaining power along with the controls for household structure, wealth indicators, and income sources.

Table 2.C.9: First stage results for alternative female bargaining power

Variables	(1) Financial decision-making
Age difference	-0.108*
	(0.0612)
Sex ratio	-0.367
	(0.269)
Age difference × sex ratio	0.0535
	(0.0528)
Age difference^2	0.00411*
	(0.00227)
Education husband	-0.0268
	(0.0204)
Education wife	0.0808***
	(0.0214)
Work wife	0.203
	(0.161)
T	0.327***
	(0.0419)
Constant	-660.1***
	(84.23)
Observations	1,943

Note: Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Age difference is defined as the husband's age minus the wife's age. Sex ratio is defined as the ratio of men over women older than 16 in the village. Education husband are the years of education of the husband. Education wife are the years of education of the wife. Work wife is a dummy variable equal to one if the wife works outside the household. T is a time dummy capturing the year effects. This regression was run for the subset of the households in 2010 and 2013.
Source: Authors' calculations.

Chapter 3

Matching food security and malnutrition indicators: Evidence from Southeast Asia

Key words: Food security, Undernutrition, Human development, Poverty, Southeast Asia
JEL classification: Q18, I15, O15

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Chapter 4

Shocks, vulnerability and income generating capacity of rural households: Evidence from Southeast Asia

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Abstract

Against the background of rising weather risks this paper seeks to understand how risks impact the income generating capacity of rural households in Southeast Asia. In this study, we use assets to predict households' income generating capacity and examine the role of different shock categories on asset accumulation. In addition, we detect region, country and income group specific patterns. We use panel data from Cambodia, Laos, Thailand, and Vietnam covering 5,200 rural households. Households' income generating capacity is estimated in a fixed-effects regression based on assets owned or accessed by the household. The findings suggest that shocks decrease the asset accumulation rate of rural households by 1.4 percentage points across all four countries. While health shocks decrease households' asset accumulation rate by 1.2 to 1.4 percentage points, the effect of drought and flood shocks is twice as high. At the country level, the effect of flood shocks on asset growth are strongest in Vietnam while drought shocks disproportionately affect Laotian households. Households are largely able to anticipate the occurrence of health shocks, while droughts and floods are less predictable and thus, have a more detrimental effect on asset growth. The effects of shocks differ across income quartiles. While households in the richest quartile are able cope with weather shocks, health shocks affect their asset accumulation disproportionately. Poor households are strongest affected by drought shocks.

Key words: Shocks, Asset-based approach, Economic development, Poverty, Regional analysis, Southeast Asia

JEL classification: I32, O18, Q1

4.1 Introduction

Despite recent advances in poverty reduction, the income generating capacity of rural households remains volatile and adverse shocks may push households back into poverty. A non-poor household may become poor due to a shock e.g. a sick household member or an adverse weather event which both affect the household's income generating capacity and subsequently its income. While all households face shocks, rural households whose income earning activities are closely connected to agriculture and environmental resource extraction are especially at risk of experiencing frequent weather shocks (Dercon, 2002). Even though weather shocks remain a common threat to all rural households, their risks and their manifestation vary by income group.

In Southeast Asia adverse shocks are common and affect rural households frequently (Gloede et al., 2015; World Bank, 2012). Despite the overall economic growth in the region, pockets of poverty persist where households are more vulnerable to idiosyncratic shocks such as illness (World Bank, 2012). Furthermore, the frequency and impact of aggregate weather shocks, especially droughts, floods, and storms, is increasing and burden public finances in Southeast Asia (Jha and Stanton-Geddes, 2013; World Bank, 2012).[1] To reduce vulnerability to poverty in the region, it is vital to develop a better understanding which households move in and out of poverty, why and with what frequency. In addition, to design targeted interventions it is important to analyze how shocks affect households with different levels of income generating capacity. This study aims to fill this gap and quantifies the effect of shocks on the asset accumulation rate of households in rural Southeast Asia. Additionally, as needs may differ along the income distribution and by country, the effects of shocks are disaggregated by income group and country.

There is a large theoretical and empirical literature which looks at vulnerability to poverty (Calvo and Dercon, 2005; Klasen and Povel, 2013; Ligon and Schechter, 2004) and the influence of shocks on household income, labor supply, and well-being in Southeast Asia (Hardeweg et al., 2013; Klasen and Waibel, 2015; Klasen et al., 2015). Due to data availability, few studies are capable to compare different income groups across countries (Klasen

[1] According to the Jha and Stanton-Geddes (2013), the Cambodian and Laotian economies are estimated to face costs of around 18 percent or more of total public expenditures in case of a 200 year event.

and Povel, 2013). To date most studies primarily explore short-run effects and largely ignore heterogeneity in terms of shock incidence and shock type by different income levels (Araujo and Pabon, 2009; Heltberg et al., 2013; Wagstaff and Lindelow, 2010). Only few studies take into account the ex-ante conditions of households by taking into account the likelihood of experiencing a shock (Gloede et al., 2015).

The results in this paper add to the literature on asset-based income generation and examines the effects of different shocks types while controlling for the likelihood of experiencing a shock. Specifically, the three research questions are: (i) How do household with and without shocks move between income groups?, (ii) What is the impact of different shocks on households' income generating capacity? and (iii) What are general region- and country-specific patterns for households in similar income groups? In the empirical analysis, we create a transition matrix and explore how households move between income quartiles across years. Second, following Attanasio and Székely (1999), Adato et al. (2006), Carter and Barrett (2006), Bussolo and Lopez-Calva (2014), and Amare and Hohfeld (2016), we estimate the impact of shocks on households' income generating capacity based on their existing asset stock and rates of returns for productive assets. Third, we specifically quantify the effect of four distinctive shocks, namely economic, health, flood and drought shocks. Fourth, we detect general regional as well as country-specific patterns for households in similar income groups.

We use representative household-level panel data from Cambodia, Laos, Thailand and Vietnam covering 5,200 rural households for our analysis.[2] The results suggest that on average, shocks decrease the asset accumulation rate of rural households by about 1.4 percentage points. However, the effects differ by shock type, country and income quartile. While health shocks decrease households' asset growth by 1.2 to 1.4 percentage points, drought and flood shocks have a considerably larger impact as they reduce asset growth by 2 to 3 percentage points. At the country level, Vietnamese households are strongly affected by floods while Laotian households are disproportionately affected by drought shocks. Our results also suggest that health shocks have a stronger impact on households in the richest income quartile while drought shocks disproportionately affect households in the poorest income quartile.

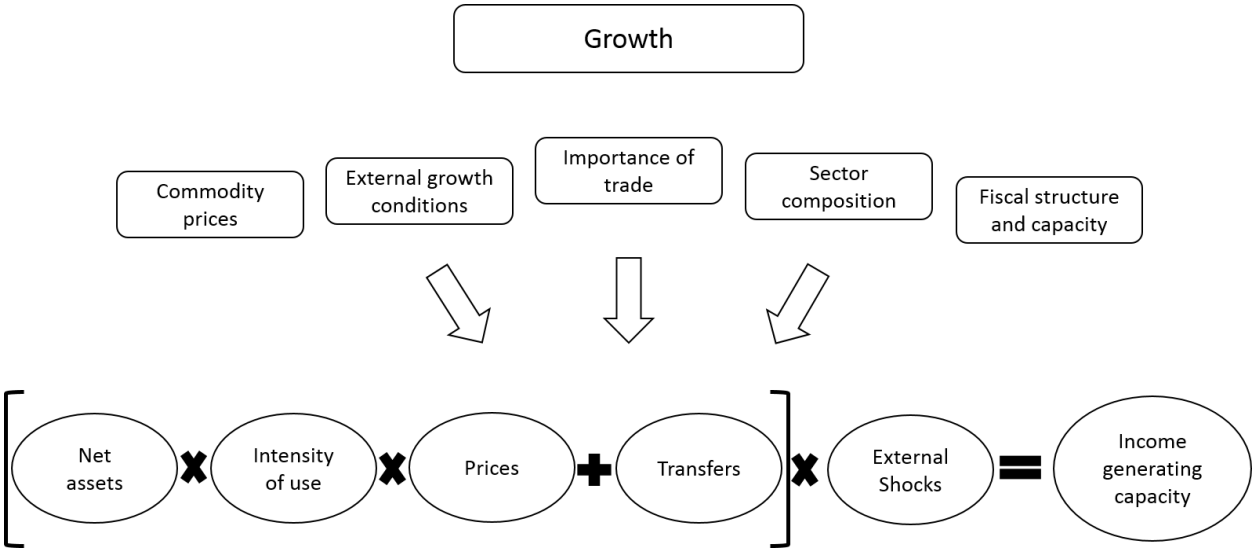
[2]The Thai and Vietnamese data originates from the Thailand and Vietnam Socio Economic Panel (TVSEP). Information can be found at the project webpage: https://www.tvsep.de/overview-tvsep.html. The Cambodian and Laotian data is from a related, two-year panel study.

The paper is set out as follows. Section 2 introduces the conceptual framework and Section 3 presents the study area and descriptive statistics. Section 4 formulates the empirical model and the different definitions of the shock variable. Section 5 reports and discusses our main results and Section 6 presents our robustness checks. Finally, Section 7 concludes.

4.2 Conceptual framework

Our framework is derived from the asset-based approach (Adato et al., 2006; Amare and Hohfeld, 2016; Bussolo and Lopez-Calva, 2014; Attanasio and Székely, 1999; Carter and Barrett, 2006) which captures the households' income generating capacity in relation to macro- and micro-level factors. The macro-level, presented in the top of Figure 4.1, includes commodity prices, external growth conditions, importance of trade for the economy, sectoral composition of growth as well as the regional fiscal structure and capacity. At the micro-level, depicted in the lower part of Figure 4.1, the households' capacity to generate income depends on the households net assets and their use intensity valued at current price levels as well as transfers received. All four main determinants at the micro-level are subject to the occurrence of external shocks.

Figure 4.1: Asset-based approach



Source: Adapted from Attanasio and Székely (1999), Bussolo and Lopez-Calva (2014) and Carter and Barrett (2006).

Net assets represent the productive assets owned or accessed by a household. Given that households in the study area - rural Southeast Asia - predominantly depend on agriculture, natural capital such as land and livestock are major components of households productive assets (Vincent, 2007; Banerjee et al., 2017). Physical capital includes transportation assets and machinery owned as well as access to common pool resources such as rivers and forests (Amare and Hohfeld, 2016). In addition, assets include human and social capital of the household and entail education and skill level, labor capacity and social interactions (Bebbington, 1999).

The intensity of use depends on a mix of factors including education and skill level as well as labor and land used for agricultural production (Adato et al., 2006; Carter and Barrett, 2006). Local prices capture the economic conditions under which a household operates. Transfers are represented by additional financial capital to which the household has access to, such as remittances, social transfers, or insurance payments received (Banerjee et al., 2017). External shocks include events such as illness, bad weather or business failure that potentially decrease household income.

Mathematically, the households' income generating capacity (Y) can be expressed as the product of household's productive asset endowments and the return on these assets (Barrett, 2005):

$$Y = A'R + \mu + \epsilon^M, \tag{4.1}$$

where A is a vector of productive assets used by the household and R is the corresponding vector of expected returns per unit of asset owned or accessed by the household. Both the assets and the rate of return are expressed in local prices. Thus, with reference to Figure 4.1, the vector of assets and their respective returns represent the households' asset endowments, the use intensity of these assets as well as associated prices. Social transfers and remittances, which are unrelated to the productivity of assets controlled by the household (e.g. lottery winnings, remittances, social transfers), are represented by μ. In addition, Barrett (2005) introduces a measurement error which is depicted by ϵ^M. Asset returns are stochastic, thus:

$$R = r + \nu^R, \tag{4.2}$$

where r denotes the expected return per asset and ν^R is an exogenous shock to asset productivity (e.g. induced by rainfall, drought, illness, or a change in economic conditions such as prices). Following Barrett (2005) the underlying assumption is that all shocks, namely the exogenous transitory income (μ), the measurement error (ϵ^M), and the exogenous shock to asset productivity have a zero mean, constant variance, and are serially independent. Thus, the mean asset-based expected income, i.e. the households' income generating capacity, is given by $E(Y) = A'r$. Substituting equation (2) into (1) and totally differentiating yields an expression for the change in household's income generating capacity as a function of changes in the asset stock, expected returns to assets and various shocks:

$$\Delta Y = \Delta A'R + A'\Delta r + A\Delta\epsilon^R + \Delta\mu + \Delta\epsilon^M \tag{4.3}$$

Given that all errors are expected to have a mean of zero and are serially independent the expected income generating capacity reduces to:

$$E(\Delta Y) = \Delta A'R + A'\Delta r. \tag{4.4}$$

Equation (3) indicates that the households' income generating capacity, i.e. its asset-based expected income, changes either through variations in the household's productive asset holdings, the rate of return or external shocks. In our empirical analysis we focus on how the occurrence of external shocks influences the households' income generating capacity and whether the effect of shocks differs along the income distribution.

4.3 Background and data description

Our study uses data from four Southeast Asian countries, Cambodia, Laos, Thailand, and Vietnam. In this section we briefly introduce the institutional setting and the data. In addition, we provide descriptive statistics on poverty and asset holdings and describe the frequency and nature of shocks reported by households in the study region.

4.3.1 Country profiles

In terms of economic development the four countries differ substantially (see Appendix, Table 4.A.1). According to their Gross Domestic Product (GDP) per capita, Cambodia, Laos, and Vietnam belong to the lower-middle-income economies, while Thailand is classified as an upper-middle-income country (World Bank, 2018b). Thailand also has the highest inequality based on the Gini index. Referring to the poverty headcount ratios at national poverty lines, the poverty incidence is highest in Laos (23% in 2012) followed by Cambodia (17% in 2012), Vietnam (17% in 2012) and Thailand (12.6% in 2012). Despite recent growth and increases in overall household wealth in Thailand and Vietnam, pockets of poverty persist in rural areas (Hardeweg et al., 2013). Life expectancy at birth, infant mortality rate, share of population with access to basic sanitation facilities, and share of population with access to electricity all support the conclusion that households in Thailand and Vietnam are better off compared to those in Cambodia and Laos.

The cultural and institutional background across the four countries is quite diverse. Thailand and Cambodia are both constitutional monarchies which operate under relatively free, market-driven policies. Laos and Vietnam belong to the four remaining countries worldwide which are governed by a one-party socialist system openly advocating communism (Gloede et al., 2015).[3] Overall, the study allows us to compare dynamics of rural households in four rather diverse countries both in terms of the economic as well as political conditions.

4.3.2 Data

The micro-economic data used in this study stems from rural household surveys conducted in Cambodia, Laos, Thailand, and Vietnam (see Figure 4.A.1 in Appendix A). The Thai and Vietnamese data originates from the Thailand and Vietnam Socio Economic Panel (TVSEP) and covers 4,000 rural households in the Thai provinces Buriram, Nakhon Panom and Ubon and the Vietnamese provinces Thua Thien Hue, Ha Tinh and Dak Lak. The Cambodian and Laotian data was collected in 2013 and 2014 by an add-on project financed by the Hannover University. It covers 1,200 rural households in the Northern province Stung

[3]The other two countries are China and Cuba.

Treng, Cambodia and the central province Savannakhet, Laos. To align the time frame, we restrict the Vietnamese and Thai sample to match the years of the Cambodian and Laotian survey.

Together, the data set covers about 5,200 rural households living in around 500 villages. The household sample in each province was randomly drawn based on a stratification process considering the heterogeneous agro-ecological conditions within the regions (Hardeweg et al., 2013). In Cambodia and Thailand each household in the survey region had an equal probability to be included in the survey, while poor households were oversampled in Laos and Vietnam (Hardeweg et al., 2013). We correct for this by applying sampling weights throughout our analysis. The data is representative for rural households in all four countries (Liebenehm et al., 2018). All monetary variables were converted to 2005 Purchasing Power Parity USD equivalents.

Across all countries an almost identical household survey was applied. It consists of nine sections covering individual information on household members (e.g. age, education, health, and employment) as well as household-level information on expenditures, shocks, risks, income earning activities such as farming, livestock raising and fishing, household financial situation, housing conditions, transfers received, and assets owned. In addition to the household survey, a village-level survey was administered to the village chief collecting information on the village location, population, infrastructure, employment, agriculture, and economic conditions.

Given the structure of the household surveys, we observe household-level income, consumption and asset holdings at two points in time, which are subsequently denoted as baseline and follow-up. The shock section is retrospective and refers to shocks that happened in the past 1 year (up to the period when the survey started). Thus, the shock section covers the time-period between the two household surveys as well as the shocks that happened in the year before the baseline survey took place. The risk section is forward-looking and asks for the shocks the household expects to face in the coming year (up to one year after the survey period). In our empirical specification we use (i) the household-level characteristics observes at baseline and the follow-up, (ii) the information about shocks that occurred between the two survey waves, (iii) the information about future risks households reported in the baseline survey.

4.3.3 Poverty and asset holdings in the sample

Our final household sample is balanced and consists of 4,686 households which are observed at baseline and the follow-up survey. The household characteristics differ significantly by country (see Table 4.1).[4] With an average income of $722 per capita households in Laos are comparatively poor. At baseline, 41% of households in Laos are considered to be poor according to the international poverty line of $1.90. Cambodian and Vietnamese households earn about $922 and $854 per capita per year, respectively. In both countries roughly every third household is classified as poor. Thai households are on average the richest with $1,820 per capita per year. This is also reflected in the low share of poor households (17%).

These differences are confirmed by financial and human capital holdings. With average remittances received between $72 and $164 per capita and an insurance coverage rate of 3% to 46%, financial capital in Cambodia and Laos is substantially lower compared to Thailand and Vietnam. Furthermore, households in Cambodia and Laos are considerably larger and include more dependent members, especially children. Education levels are low and almost half of the average education level in Vietnam (3.5 versus 6.8 years).

Asset holdings for natural and physical capital are rather diverse. With 0.96 hectare, land holdings are smallest in Vietnam. However, in Vietnam land is centrally distributed to farmers and each household is granted a similar amount of land for farming (Do et al., 2017; Markussen et al., 2011). The value of agricultural production assets varies between $31 per capita in Laos and $45 in Cambodia. With $1,798 and $3,162 transportation assets in Cambodia and Laos are higher than in Vietnam. However, transportation assets include not only vehicles but also boats. Given that households in Cambodia and Lao are engaged in fishing and logging this might explain the rather high amount of transportation assets. Household appliances, which include furniture, kitchen and entertainment equipment, are higher in Thailand and Vietnam.

While all households in the area are prone to shocks, the occurrence and frequency of shocks differs across regions (see Table 4.1). With 3.9 shocks Cambodian households experience comparatively more adverse events, while Thai households experience only about 2 shocks per year. In line with previous research on this data set (Do et al., 2017; Gloede et al., 2015),

[4] In relation to the initial sample size this is equivalent to an attrition rate of almost 10%

Table 4.1: Descriptive statistics at baseline by country

	Cambodia		Laos		Thailand		Vietnam	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Financial Capital								
Remittances^{+}	72.20	320.89	164.39	418.36	568.80	1034.80	361.89	923.24
Access to insurance (1=yes)	0.03	0.17	0.46	0.50	0.99	0.08	0.88	0.33
Human Capital								
Household size	5.12	1.91	5.93	2.50	4.06	1.70	4.27	1.71
Number of children	1.91	1.39	2.21	1.71	1.20	1.07	1.35	1.25
Number of elderly	0.31	0.59	0.34	0.60	0.68	0.81	0.51	0.77
Education hh head (years)	3.48	3.24	3.43	3.78	4.39	3.04	6.83	4.46
Age hh head (years)	44.89	13.81	49.80	13.39	57.17	12.49	50.40	13.34
Gender hh head (1=female)	0.12	0.33	0.15	0.35	0.27	0.44	0.16	0.37
Natural Capital								
Land size in ha	2.71	2.80	2.16	1.98	3.39	3.55	0.96	3.21
Livestock in TLU	0.13	0.26	0.08	0.21	0.25	0.64	0.27	0.52
Distance to forest$^{\#}$	3.65	3.69	2.63	1.73	3.41	4.31	2.56	6.61
Distance to water-body$^{\#}$	2.28	3.09	1.24	1.53	1.97	3.40	0.24	1.68
Physical Capital								
Transportation assets^{+}	363.91	555.42	643.44	1159.45	1255.74	2410.34	294.59	618.75
Agricultural assets^{+}	45.76	82.57	30.68	118.28	40.21	102.04	38.33	95.93
Household appliances^{+}	69.03	245.71	141.44	313.13	239.85	297.67	205.36	237.10
Size house in m^2	56.90	29.76	71.17	35.40	81.68	43.96	64.64	35.92
Social Capital								
Communication assets^{+}	6.14	8.98	12.40	20.14	26.26	50.06	31.96	71.51
Ethnicity	0.81	0.39	0.48	0.50	0.94	0.24	0.79	0.40
Membership political party	0.61	0.49	0.00	0.00	0.11	0.31	0.90	0.30
Income & Poverty								
Income gen. capacity^{+}	922.24	144.56	722.05	119.39	1820.50	261.72	854.56	126.62
Income per day^{+}	2.53	0.40	1.98	0.33	4.99	0.72	2.34	0.35
Poverty (regional)^{o}	0.34	0.47	0.29	0.46	0.60	0.49	0.36	0.48
Poverty (international)^{ø}	0.33	0.47	0.41	0.49	0.17	0.37	0.36	0.48
Shocks								
Number of shocks	3.86	2.83	2.54	2.22	2.00	2.06	2.79	2.32
Number of economic shocks	0.08	0.32	0.07	0.26	0.08	0.29	0.14	0.36
Loss from economic shocks^{+}	0.00	0.00	0.00	0.00	0.79	9.68	4.52	37.03
Number of health shocks	0.69	0.76	0.38	0.52	0.22	0.44	0.27	0.53
Loss from health shocks^{+}	9.03	67.12	15.16	74.11	0.77	12.18	0.95	18.46
Number of weather shocks	0.43	0.57	0.39	0.59	0.32	0.52	0.27	0.49
Loss from weather shocks^{+}	29.11	84.04	43.49	89.34	32.80	141.95	2.71	33.39
Observations	484		470		1,872		1,860	

Note: $^{+}$Monetary values are all given in per capita Purchasing Power Parity US Dollar to base year 2005; $^{\#}$in km, measured at village-level; ^{o}regional poverty lines apply - for details see Table 4.A.2; ^{ø}international poverty line of \$1.90. ^{s}Shock group definitions: The economic shocks include the categories strong decrease of prices for output, strong increase of prices for input, could not afford to buy food to increasing prices, lack of food availability on the market. The health shocks include illness, death, or accidents of household members. The weather shocks include drought and flood shocks.
Source: Authors' calculations.

health and weather shocks make up the majority of shocks. However, while health shocks appear rather frequent, their impact on household assets is moderate. Still the average losses from health shocks in Cambodia and Laos exceed the losses in Thailand and Vietnam. This is partly due to the relatively high share of 'out-of-pocket' health expenditures and the poor health system which means households turn to private clinics (if they can afford it) or traditional healers (Kenjiro, 2005; Levine et al., 2016; Ros et al., 2015). The impact of weather shocks on assets is more detrimental in all four countries.

4.4 Empirical model

In this section we introduce the empirical model which we use to predict the households' income generating capacity. First, we specify the econometric model to derive the asset-based expected income as established in the literature (Amare and Hohfeld, 2016; Carter and Barrett, 2006). Second, we present our asset accumulation model in which we allow for the occurrence of different shocks. Third, we introduce the shock indicators used in this study and present the robustness tests applied to prove the validity of our results.

4.4.1 Household income generating capacity

Following Amare and Hohfeld (2016) and Carter and Barrett (2006), we predict households' income generating capacity based on net assets, intensity of use, prices and transfers. The household-level fixed-effects regression is specified as:

$$Y_{it} = \alpha + \beta_i(A_{it}) + \sum_j \beta_{jt}(A_{it})A_{ijt} + \gamma G_t + \delta_{pt} + \eta_i + \epsilon_{it}, \tag{4.5}$$

where Y_{it} is the income generating capacity of a household which we approximate by expenditures of household i at time t divided by the rural poverty line (Amare and Hohfeld, 2016).[5] Thus, Y_{it} takes on values below one for households with expenditures below the poverty line and values above one for households that are non-poor. A_{it} is a vector of net assets owned or accessed by the household (i) at time t. Based on the literature (Banerjee et al., 2017;

[5]We use rural poverty lines published by the respective country, see Appendix Table 4.A.2.

Bebbington, 1999; Do et al., 2017; Nguyen et al., 2017), we form subcategories for financial, human, natural, physical, and social capital (see Table 4.1 for overview of variables).

Since the return per asset depends also on the level of other assets owned or accessed by the household the vector $(A_{it})A_{ijt}$ interacts all assets (i) with all other assets (j) owned or accessed by the household. Macro-level influences such as prices, the general economic condition, and potential public transfers are captured by province fixed-effects (δ_{pt}) and open access to resources at the village-level (G_t). Household fixed-effects (η_i) capture differences between households that are time invariant.

Subsequently we calculate the fitted values to estimate the asset-based expected income:

$$\Lambda_{it} = \sum_j \hat{\beta}_{jt}(A_{it})A_{ijt}, \tag{4.6}$$

where Λ_{it} represent our index in which assets are weighted according to their marginal contribution to households' income generating capacity given by the estimated coefficient $\hat{\beta}_{jt}$. For our analysis we use the asset-based income generating capacity Λ_{it} to distinguish between poor and non-poor households. In addition, we also disaggregate effects by consumption quartiles.

4.4.2 Asset accumulation

Based on the conceptual framework we estimate two models to examine the impact of different shocks on asset accumulation. In both cases the dependent variable is the asset-based income generating capacity.

First we estimate the impact of household-level shocks on asset growth using the following regression equation:

$$\Delta\Lambda_i = \alpha + \psi_1 S_i + \gamma_1 HH_i + \gamma_2 A_v + \gamma_3 G_v + \pi_i \tag{4.7}$$

where $\Delta\Lambda_i$ refers to the accumulation of assets between *t-1* and *t*. The variables of interest are captured by S_i which is a vector of shock indicators. Throughout the specifications we use two different types of shock indicators: (a) an aggregate shock indicator which takes on

the value of one if the household reported any shock between the baseline and the follow-up and is zero otherwise, and (b) specific shock indicators for flood, drought, health, and economic shocks to differentiate the effects by shock type. HH_i is a vector of household characteristics which controls for household size, education, gender and age of the household head, off-farm and self-employment activities, and access to sanitation, drinking water and electricity. Further, we control for the village mean of initial asset-based expected income (A_v) and initial village-level assets (G_v) including topography, social problems within the village, infrastructure, and access to basic public goods.

Second, the effects of shocks on households' income generating capacity may differ by their initial economic status i.e. asset base or income generating capacity. To allow for differential effects by economic group we employ a quartile regression. The specification is analogue to equation 4.7.

4.4.3 Definition of shock variable

In our main regressions we use two different ways to capture shocks. First, we use a simple shock indicator which is equal to one if the household reported any shock in the reference period and zero otherwise. Second, we disaggregate the shock indicator into four shock categories to capture the major types of shocks observed in our sample, namely economic, health, drought and flood shocks. In line with previous studies (Bühler et al., 2015; Do et al., 2017; Gloede et al., 2015) we use the following shock group definitions: (i) Economic shocks include the categories 'price fluctuations' and 'product availability on the market'; (ii) health shocks include 'illness', 'death', or 'accidents of household members'; and weather shocks which are separated into (iii) drought and (iv) flood shocks.

While the shocks themselves are exogenous, the probability to experience and report a shock might differ across the sample due to regional differences and/or income inequality which leads to a different level of being affected (Dercon and Krishnan, 2000; Gertler et al., 2000; Hoddinott and Quisumbing, 2003). Therefore, we perform a series of robustness checks throughout our estimations to verify the validity of our shock indicator.

One main concern in relation to shocks and their effect on household's asset accumulation is that the probability of experiencing and reporting a shock may be correlated to the household's location or welfare. We test for this bias using a simple OLS regression which

uses income quartiles to predict the probability of reporting a shock. The results (see Table 4.B.3 in Appendix B) reveal that households in the richest quartile are significantly less likely to experience a shock compared to households in the other quartiles. However, while the coefficient is significant at the 1 percent level, the magnitude is small i.e. households in the richest quartile are 4.7 percent less likely to experience a shock compared to households in the other quartiles.

Throughout the empirical analysis we address the concern in three ways. First, we control for the shock probability at the village-level expressed as the share of households per village who experienced a shock divided by the total number of households in the village. Therewith, we account for the likelihood of shocks at the village-level and control for any regional differences that potentially drive our results. The results are reported in the main regression tables.

Second, we address the concern that households form expectations regarding the realization of shocks. We follow the approach described by Gloede et al. (2015) and define a surprise shock indicator as the mean difference between reported shocks and anticipated risks for each shock type. Basically, shocks are weighted against the household's expectation of shocks and shocks that the household does not anticipate are assigned a higher weight. This measure allows us control for the expectation formation at the household-level. Results are reported in Section 6.

Third, we employ an instrumental variables (IV) approach to address the endogeneity related to the household's location choice and potential differences in shock reporting. Following Bartik (1991) and Altonji and Card (1991), we combine average village-level assets at baseline with the geographic distribution of shocks at the sub-district-level to instrument the shock indicator. While the household's shock reporting is likely biased due to unobservables the share of households at the sub-district-level which experience a shock and the average village-level asset-base at baseline are exogenous to the household. For the regression specification please refer to Appendix B. Results are reported in Section 6.

4.5 Results

In this section we present the results of our analysis. First, we present descriptive results regarding the economic mobility of households across the two waves. Second, we analyze

asset growth in the presence of shocks for the whole sample. Third, we present results for the heterogeneous effects of shocks across different income quartiles.

4.5.1 Welfare dynamics

In order to assess welfare dynamics, we examine the economic mobility of households between asset-based income quartiles over time (Table 4.2). Households are grouped into quartiles in both time periods and we determine the percentage of households who stayed in the same quartile or moved to a different quartile in the follow-up. Furthermore, we perform two sided t-tests for households with versus households without shocks.

The majority of household (67%) which are classified as Bottom 25% at baseline remain in the poorest quartile in the follow-up. However, a substantial share (34%) move into higher income quartiles in the follow-up. 21% move into the second lowest income quartile, 10% into the second highest, and 3% into the Top 25%. Still, this indicates that extreme poverty is quite persistent for households in our sample and the majority of households in this groups remains poor over time. Similarly, the majority of households (63%) which are classified as Top 25% at baseline remain in the richest quartile. While 27% of households which leave the top quartile move into the second highest quartile, about 2% move into the poorest quartile. Thus, even households which appear economically more secure are at risk of sliding back into poverty between years indicating that households are not able to keep the standard over time. However, this concerns only a small share of households.

The mobility patterns differ by country (see Appendix, Figure 4.C.2). In Cambodia and Laos none of the households in the Bottom 25% managed to climb out of poverty between the baseline survey and the follow-up. Likewise, none of the households from the Top 25% fell back into complete poverty in the follow-up. In Thailand and Vietnam economic mobility is more dynamic. While poverty appears to be more transient in Thailand (only 36% remain in extreme poverty in both waves), it is still persistent in Vietnam (58% of extremely poor households remain poor). On the other hand, even households which are categorized as Top 25% at baseline face a 12 to 13% chance to fall back into poverty.

Results from a two-sided t-tests (see Table 4.C.4) show that households who do not experience shocks receive on average more remittances and are more likely to have access to

insurance. In addition, households with shocks have significantly more household members and a higher number of children. While education and natural capital do not differ, households who do not experience shocks have significantly larger physical and social capital holdings. Lastly, household income is larger for households without shocks and they are less likely to be poor.

Table 4.2: Economic mobility of households between quartiles

		Follow-up			
		Bottom 25%	Quartile 2	Quartile 3	Top 25%
Baseline	Bottom 25%	67%	21%	10%	3%
	Quartile 2	24%	44%	22%	10%
	Quartile 3	7%	27%	42%	24%
	Top 25%	2%	8%	27%	63%

Source: Authors' calculations.

Overall, poverty appears to be more persistent in Cambodia and Laos compared to Thailand and Vietnam. Yet, in Thailand and Vietnam richer households are more likely to fall back into poverty while it is still rather unlikely for households from the Bottom 25% to exit poverty in the short-term. Across all four countries, the mean comparison shows that shocks reduce households' asset holdings and increase the probability to remain in poverty.

4.5.2 Asset growth in the presence of shocks

In this section we explore the relation between shocks and asset accumulation. The analysis is split in three parts. First, we consider the aggregate effect of any type of shock on asset growth. Second, we disaggregate into the major four shock types: economic, drought, flood, and health shocks. Finally, we disaggregate by shock type and country to shed light on different impacts at the country level. The first step results for the fixed-effects household estimation to predict households' income generating capacity based on assets are reported in the Appendix, Table 4.C.5.

Our main results are presented in Table 4.3 and Figure 4.2. The overall influence of shocks on asset growth is significant and negative, see columns (1) and (2). The point estimate (-0.018) shows that shocks reduce growth of households' income generating capacity (or asset growth)

by 1.4 percentage points.[6] In monetary terms, the income generating capacity of households with a shock reduces by $17 per capita which is equivalent to between 3 (Thailand) and 9 days (Laos) of per capita daily income (see Table 4.1). The results are robust to the inclusion of all control variables as well as controlling for the village-level shock probability (columns 2 and 4). Thus, regional differences in shock probability do not drive the results.

Table 4.3: Household income generating capacity and shocks

Variables	(1) Asset growth	(2) Asset growth	(3) Asset growth	(4) Asset growth
Shock	-0.0178***	-0.0110**		
	(0.0054)	(0.0050)		
Economic shock			0.0020	0.0029
			(0.0075)	(0.0070)
Drought shock			-0.0102*	-0.0051
			(0.0053)	(0.0051)
Flood shock			-0.0136*	-0.0110
			(0.00712)	(0.0068)
Health shock			-0.0174***	-0.0107**
			(0.0049)	(0.0046)
Country fixed-effects	x	x	x	x
Shock probability		x		x
Household controls		x		x
Observations	4,686	4,686	4,686	4,686
Adjusted R^2	0.0409	0.179	0.0418	0.179
F-value	57.42	38.92	34.82	34.57
Root mean square error	0.151	0.140	0.151	0.140

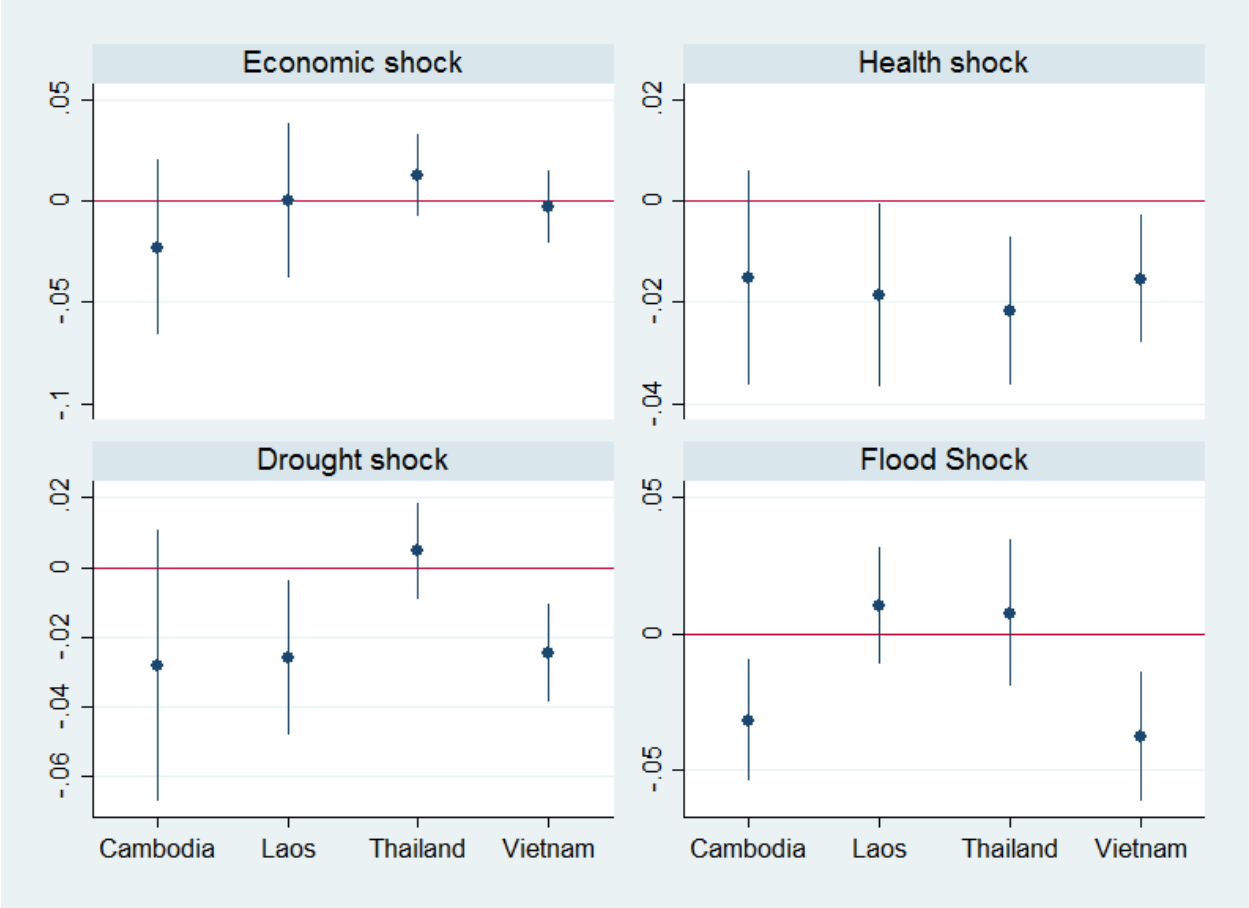
Note: Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Household controls: household size, number of children, number of elderly, average education, membership political party, age household head, gender household head, self-employment, off-farm employment, access to sanitation, access to drinking water, access to electricity; village characteristics: paved road, violence, epidemics, irrigation, village-level average asset stock at baseline.
Source: Authors' calculations.

The results, reported in columns (3) and (4), show that the overall negative effect is mainly driven by health shocks. Drought and flood shocks, on the other hand, appear to be significant at the 10% level but become insignificant once the household controls are included (column 6). Economic shocks are overall insignificant in both specifications. From an economic point of view, the income generating capacity of households which experience a health shock decreases between $10 to $17 per capita compared to households without any health

[6]The average increase in the income generating capacity is $0.244 pc/day. In relation to the asset-based predicted income of $1.298 pc/day at baseline this in an increase by 19 percent. The shock coefficient suggests that the income generating capacity decreases by $0.0178 pc/day which means households' income generating capacity grows only by 17.7 percent. In relation to the average household income generating capacity of $1,234 for the baseline year households without a shock increase their income generating capacity by $236 pc/year whereas households with a shock only increase their income generating capacity by $219 pc/year.

shocks. This roughly corresponds to the losses from health shocks reported by households in Laos and Cambodia (see Table 4.1). Similarly, households' income generating capacity reduces by $10 for households which experience a drought shock and by $13 for households which experience a flood shock. This is in line with earlier research by Kenjiro (2005) who shows that illness causes more economic damage than crop failure in Cambodia.

Figure 4.2: Marginal effects of shocks by country



Note: Controls for shock probability are included.
Source: Authors' calculations.

In a second step we separate effects by shock type and country. The results, shown as marginal effects in Figure 4.2 (and Table 4.C.6 in Appendix C), confirm that economic shocks are not significant. This is related to both the estimation as well as the sample. Covariate shocks are partly captured in the geographic controls included in the first stage regression. In addition, our sample includes mainly marginalized households who are not engaged in medium or large scale business and consequently report only very few incidences

of economic shocks (between 0.08 to 0.14 economic shocks on average, see Table 4.1). The majority of households is engaged in agriculture where weather related shocks are common and more destructive which is confirmed by previous research using the same data set (Do et al., 2017; Gloede et al., 2015) as well as the descriptive statistics (see Table 4.1).

Similar to the overall results, the country-level results confirm that health shocks decrease the income generating capacity of households in all four countries. However, the effect is only statistically significant in Laos, Thailand and Vietnam. With a decrease of 1.2 to 1.4 percentage points the change in the growth rate is quite similar across the three countries. Given the different income levels, the monetary impact in Laos and Vietnam ($10 per capita per year) is smaller compared to Thailand ($31 per capita per year).

The effects of weather related shocks differ across countries. While drought shocks have a significant negative effect on asset growth in Laos and Vietnam, we find a positive, yet insignificant, effect of drought shocks on asset growth in Thailand. Flood shocks, on the other hand, have no significant effect on asset growth for households in Laos and Thailand but a significant negative effect in Cambodia and Vietnam. This is in line with previous research (Gloede et al., 2015) and reflects the different geographic and local climatic conditions. Both, drought and flood shocks, have a stronger effect on asset growth compared to health shocks. Drought shocks decrease income growth by about 2 percentage points which is equivalent to $14 to $17 per capita per year. The influence of flood shocks is even stronger as affected households have a 2.4 to 3 percentage point lower income growth equivalent to $22 per capita per year for Cambodian households and $26 per capita per year for Vietnamese households.

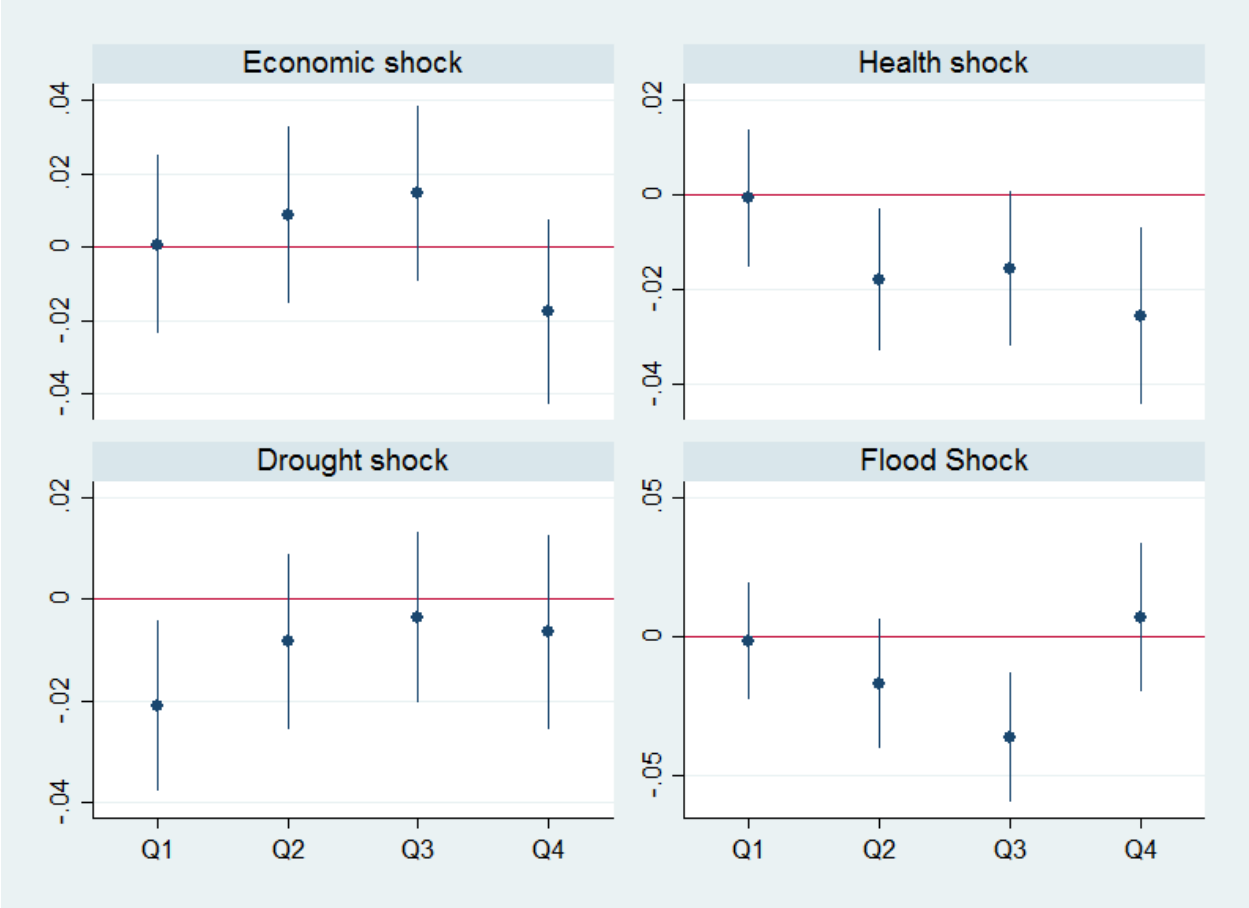
Overall, our results suggest that health, drought and flood shocks significantly decrease the income generating capacity of rural households in Southeast Asia. While the impact of health shocks is strongest in Thailand, drought and especially flood shocks significantly decrease income growth for households in Cambodia, Laos and Vietnam.

4.5.3 Heterogeneous effects along the income distribution

In this section we examine the differential impact of shocks per income quartile. Given that the influence of shocks on asset accumulation differs significantly across countries, we expect that they have differential effects along the income distribution. First, we present

the marginal effects of shocks for each income quartile. Second, we distinguish the effect per quartile by country.

Figure 4.3: Marginal effects of shocks by income quartile



Note: Country fixed-effects and control for shock probability are included. Q1 to Q4 refers to the income quartiles.
Source: Authors' calculations.

The marginal effects by shock types and income quartile are presented in Figure 4.3 (and Table 4.C.7 in Appendix C). The results suggest that the income generating capacity of households differs substantially by quartile. Health shocks significantly reduce income growth for households in the upper three quartiles. The effect on the growth rate varies between 1.2 for households in quartile 3 to 2 percentage points for households in the richest quartile. While poor households are not less likely to experience health shocks compared to households in the richer quartiles, health shocks do not seem to reduce the income growth of poorer households. However, this does not mean poorer households are not affected by health

shocks but rather indicates that we find no significant effect of health shocks on their income generating capacity. There are two possible explanations for this finding. First, since poor households are mainly engaged in agriculture, illness of one particular member might not reduce the overall income generating capacity of the household. Second, richer households might use their asset base to pay for medical treatment and thus, through the sale of assets, reduce their income generating capacity (Kenjiro, 2005; Levine et al., 2016; Ros et al., 2015).

Drought and flood shocks appear to be more harmful for households in particular income quartiles. While drought shocks appear to be most detrimental for poor households, flood shocks have a strong negative effect for households in quartile 3. On average, drought shocks decrease the income growth of poor households by 1.6 percentage points, which is equivalent to a decrease of the income generating capacity by $17 per capita per year. Similar to the country-level results from Section 5.2 the magnitude of flood shocks exceeds those of the other shock events. Income growth of households in quartile 3 reduces by almost 3 percentage points which is equivalent to $36 per capita per year or up to 19 days of daily income (see Table 4.1).

4.6 Validity of results

In this section we address potential validity concerns related to the shock indicator and the arbitrariness of the welfare quartiles presented before. First, we present evidence that if anything the shock indicator we use for our main results gives lower bound estimates in terms of the decrease in asset growth. Second, we address how meaningful our quartile regression is for policy makers and show that our results are similar when applying cross-validated cut-offs.

4.6.1 Robustness of shock indicator

One major concern is the potential endogeneity of the shock indicator. We address this reporting bias in two ways: (i) we construct a surprise shock indicator to account for the expectation formation regarding shocks at the household-level and (ii) we implement a two-stage-least-squares estimation and use a Bartik-type instrument to predict household-level shocks to overcome the potential endogeneity.

The results for the surprise shock indicator, displayed in Table 4.4, suggest that indeed the effect of unexpected shocks is about two thirds higher compared to the main results from Section 5. Accordingly, household asset growth decreases by 2.4 percentage points which is equivalent to $31 per capita per year. However, once all the control variables are included, the coefficient is insignificant. At the country level, the results confirm the importance of drought and flood shocks for Vietnam and Cambodia (see Table 4.D.8 in Appendix D). While the main results show that health shocks matter for households' income generating capacity, the results from Table 4.4 and 4.D.8 suggest that health shocks have no significant effect when controlling for households' expectations. Thus, households are aware of the risk associated to health shocks. However, as the main results show, households' income generating capacity still reduces if health shocks occur despite the fact that households are aware of the risk. Therefore, it is important to strengthen the health systems and to provide access to health care for rural households in the region.

Table 4.4: Asset growth and unexpected shocks

Variables	(1) Asset growth	(2) Asset growth	(3) Asset growth	(4) Asset growth
Unexpected shock index (USI)	-0.0324**	0.00344		
	(0.0149)	(0.0142)		
Unexpected economic shock index (UESI)			-0.00831	0.0231
			(0.0180)	(0.0171)
Unexpected health shock index (UHSI)			-0.0144	-0.00672
			(0.00892)	(0.00807)
Unexpected drought shock index (UDSI)			0.00244	0.000255
			(0.00408)	(0.00384)
Unexpected flood shock index (UFSI)			-0.0149***	0.000556
			(0.00499)	(0.00486)
Country fixed-effects		x		x
Household controls		x		x
Observations	4,682	4,682	4,682	4,682
Adjusted R squared	0.000692	0.177	0.00161	0.177
F-value	4.714	40.48	3.205	35.60
Root mean square error	0.154	0.140	0.154	0.140

Note: Marginal effects per country and shock type * quartile are displayed. Standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Household controls: household size, number of children and elderly, education, membership political party, self-employment, off-farm employment, access to sanitation, drinking water and electricity; household head characteristics: age and gender; village characteristics: paved road, violence, epidemics, irrigation, average asset stock at baseline.
Source: Authors' calculations.

Second, we present the results from our IV estimation which addresses the potential downward bias of the shock effect due to the reporting bias. The first stage results (see Table 4.D.9 in Appendix D) show that the instrument is meaningful and fulfills Stock and Watson's

rule of thumb.[7] The second stage results, displayed in Table 4.5 suggest that the true effect of shocks on household income growth is indeed higher than the results presented in Section 5. Accordingly, household asset growth decreases by 12 to 29 percentage points which is equivalent to $156 to $359 per capita per year or 82 to 190 days of income.[8] However, while the regression in Section 5 gives the average treatment effect (ATE) i.e. the effect of a shock for all households, the instrumental variables regression estimates the local average treatment effect (LATE) which is the average effect for households who experience a shock as projected by the instrument.

Table 4.5: Instrumental variables regression

Variables	(1) Asset growth	(2) Asset growth	(3) Asset growth
Shock	-0.427** (0.209)	-0.485* (0.256)	-0.438 (0.284)
Country fixed-effects		x	x
Household controls			x
Observations	4,686	4,686	4,686
F-value first stage	107.16	57.24	17.11
Root mean square error	0.226	0.244	0.225

Note: Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Household controls: household size, number of children, number of elderly, average education, membership political party, age household head, gender household head, self-employment, off farm employment, access to sanitation, access to drinking water, access to electricity; village characteristics: paved road, violence, epidemics, irrigation, average village-level asset stock at baseline.
Source: Authors' calculations.

4.6.2 Policy relevant economic classes

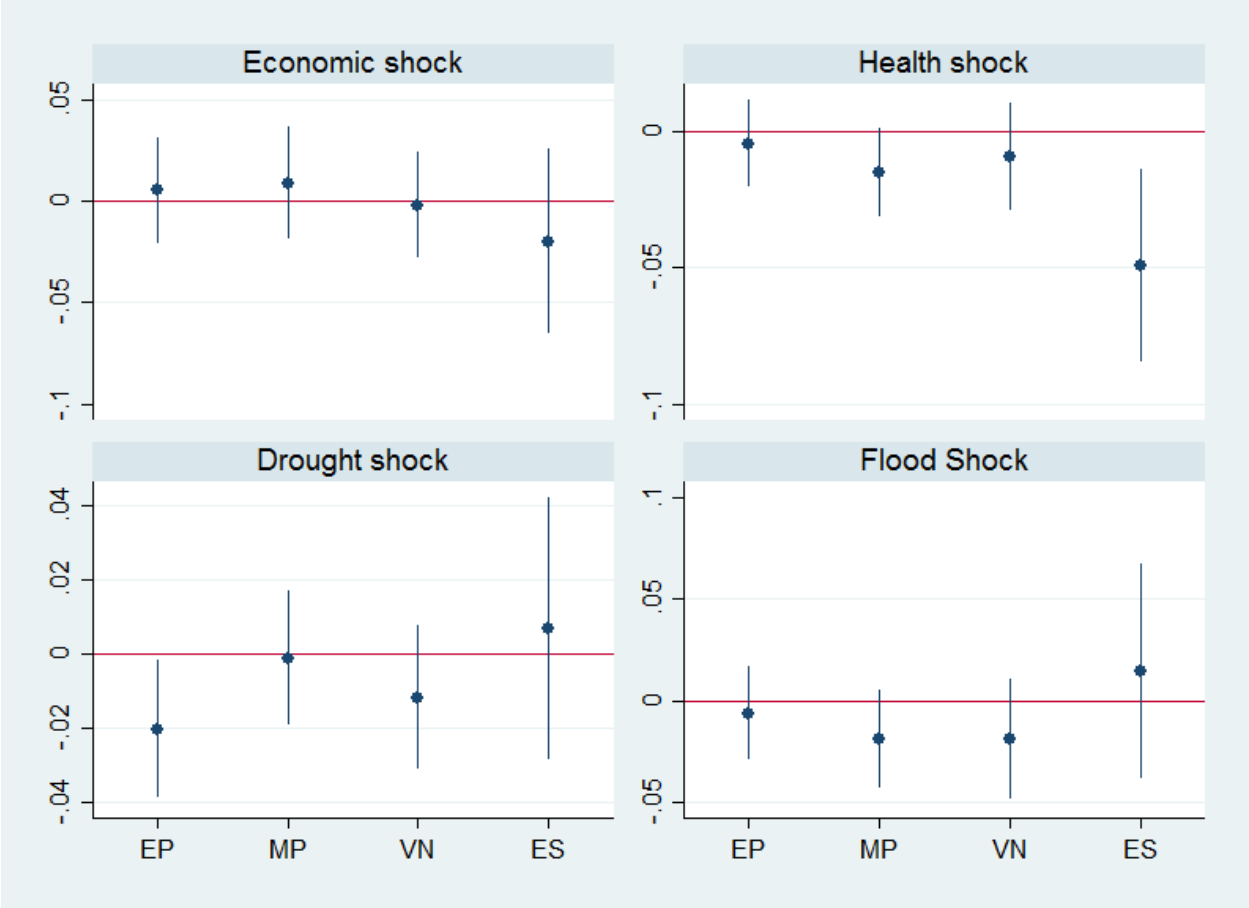
From a policy perspective the simple income quartiles used in this study may not be the most informative. Previous research in the region has identified five economic classes in terms of households' economic prosperity (Cunningham and Huertas, 2018; World Bank, 2018a). In an effort to inform policy makers about the needs across different economic groups we

[7] An instrument is relevant if the first-stage F-value exceeds the value of 10 (Stock, 2011).

[8] The coefficient suggests that asset growth decreases by $0.427 pc/day which means the income generating capacity grows only by 7 percent versus 19 percent for households without shocks. This translates into a reduction of the income generating capacity by $156 to $359 per capita per year.

replicate our analysis to include these previously identified groups instead of the quartiles.[9] Since our sample covers rural households we drop the richest group.

Figure 4.4: Marginal effects of shocks by economic class



Note: EP - Extremely Poor, MP - Moderately Poor, VN - Vulnerable, ES - Economically Secure.
Source: Authors' calculations.

The results for the economic groups, reported in Figure 4.4, are largely in line with the findings from the quartiles. Health shocks have a significant and negative impact on asset growth of the relatively wealthier households (the group of economically secure households). Drought shocks, on the other hand have a significant negative effect for extremely poor households. The effects of economic or flood shocks are not statistically significant.

[9]The economic classes from the regional World Bank study are defined as follows: (i) extreme poor - less than $1.90 PPP per day, (ii) moderately poor - between $1.90 to $3.10 PPP per day, (iii) vulnerable - between $3.10 to $5.50 PPP per day, (iv) economically secure - between $5.50 to $15 PPP per day, and (v) global middle class - $15 to $50 PPP per day.

4.7 Conclusion

In this paper we use data from rural households across four countries in Southeast Asia to analyze the effect of shocks on households' income generating capacity. Using the asset-based approach, we specifically investigate the effects of droughts, floods, economic, and health shocks on rural households. In addition, we disaggregate the effects by country and income group to detect regional as well as distributional differences.

Our findings suggest that even though rural households in Cambodia, Laos, Thailand, and Vietnam face a similar probability of shocks, the type and effect of the shocks varies across countries and income quartiles. Economic shocks do not play a major role for households' income generating capacity in our sample. Health and weather related shocks show a strong and significant effect on household asset growth. While health shocks reduce the growth rate of households in all countries by 1.2 to 1.4 percentage points, the effect of drought and flood shocks is stronger but differs across countries. Drought shocks decrease households' income generating capacity by 2 percentage points in Laos and Vietnam. With a decrease of 2.4 to 3 percentage points flood shocks hit households in Cambodia and Vietnam even harder. In monetary terms, the effect of shocks reduces households' income generating capacity by \$17 to \$36 per capita per year which is equivalent to as much as 19 days of income in Laos.

The income quartile regression reveals that in addition to country-level differences the effect of shocks varies by income group. Households in the poorest income quartile disproportionately suffer from drought shocks, while health shocks significantly reduce the income generating capacity of households in all but the poorest income quartile. Flood shocks reduce income growth for households in quartile one to three, yet, the effect is only significant for households in the third quartile. The effects are robust to changing the group cut-offs to the economic groups defined in a broader regional study by the World Bank (Cunningham and Huertas, 2018; World Bank, 2018a).

The results from our robustness tests show that households in the region form expectations about the likelihood with which shocks occur in the future. While health shocks are largely anticipated by households, weather related shocks, such as droughts and floods, remain unpredictable to a certain extent and their effect on households' income generating capacity is more detrimental. However, while households are able to anticipate health shocks, these

shocks still reduce household's asset accumulation. Furthermore, the results from the IV regression suggest that the true effect of shocks is likely higher than the effect predicted by the OLS regression.

Against the background of higher frequency extreme weather events, policy makers should not just count on the expectation formation of rural households but rather support collective actions and community responses at the local level. Policies aiming at poverty reduction in rural areas need to take into account the situation of different economic groups. Therefore, better-targeted programs are needed which support asset accumulation, improve their use, and offer protection or immediate support in case of weather shocks. Furthermore, there is a need to strengthen access to affordable health care to enable households to cope with the anticipated, yet uninsured, health risks. Given that even richer households' are not able to deal with foreseeable health issues, improved worker protection that is affordable would be one way to reduce the pressure on rural households.

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4.A Appendix A

Figure 4.A.1: Study area

Source: Authors' representation.

Table 4.A.1: Development indicators by country

Indicator	Cambodia	Laos	Thailand	Vietnam
Access to electricity (% of population)	49.7	87.1	100	100
Access to basic sanitation service (% of population)	48.8	72.6	78.2	95.0
Life expectancy at birth (in years)	68.98	66.68	75.30	76.25
Mortality rate, infants (per 1,000 live births)	27.5	48.9	10.5	17.6

Source: World Bank (2018b).

Table 4.A.2: Rural poverty lines per capita per day

Country	Year	Local currency	PPP USD 2005
Cambodia[a]	2009	3503.00	1.93
Laos[b]	2009	6315.79	1.48
Thailand[c]	2010	66.83	3.69
	2013	75.77	3.76
Vietnam[d]	2010	13333.33	1.89
	2013	19000.00	1.90

[a]Source: Ministry of Planning (2013); [b]Source: Asian Development Bank (2014); [c]Source: National Statistical Office (2016); [d]Source: General Statistics Office (2017).

4.B Appendix B

Table 4.B.3: Probability to experience a shock by quartile

Variables	(1) Shock likelihood	(2) Shock likelihood	(3) Shock likelihood
2^{nd} Quartile	-0.0291*	-0.0189	-0.000935
	(0.0168)	(0.0167)	(0.0176)
3^{rd} Quartile	-0.0536***	-0.0329*	-0.0190
	(0.0171)	(0.0173)	(0.0191)
4^{th} Quartile	-0.115***	-0.0763***	-0.0470**
	(0.0178)	(0.0186)	(0.0204)
Constant	0.805***	0.873***	0.886***
	(0.0116)	(0.0185)	(0.0820)
Country fixed-effects		x	x
Village fixed-effects			x
Observations	4,733	4,733	4,733
R^2	0.010	0.027	0.204
F-value	14.69	23.18	-
Root mean square error	0.428	0.424	0.406

Notes: Robust standard errors in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations.

Instrumental variables approach

The idea of using regional shares and weighting them by a baseline composition is widely used in the labor and trade economics literature. Initially the instrument was proposed by Bartik (1991) and since then has been used in numerous publications to isolate labor market shocks (see Jaeger et al. (2018) for an overview).

Formally the two-stages-least-squares procedure takes the following from:

$$\hat{S}_{it-1} = \alpha + \beta_1 A_{vt-1} + \beta_2 \frac{1}{N-1} \sum_{n \neq i}^{N} (S_{st-1}) + \beta_3 A_{vt-1} * \frac{1}{N-1} \sum_{n \neq i}^{N} (S_{st-1}) + \gamma_1 HH_{it-1} + \gamma_3 G_{vt-1} + \pi_{it} \tag{4.8}$$

and

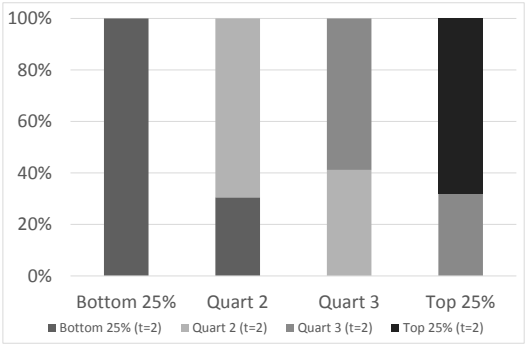
$$\Delta\Lambda_{it} = \alpha + \psi_1 \hat{S}_{it-1} + \psi_2 W_{it-1} + \gamma_1 HH_{it-1} + \gamma_2 A_{vt-1} + \gamma_3 G_{vt-1} + \pi_{it} \tag{4.9}$$

Where the household-level (i) shock indicator S_{it-1} is instrumented by the share of other households at the subdistrict level (s) which had a shock weighted by the average village-level asset-based expected income at baseline (A_{vt-1}). Household controls (HH_{it-1}) and other village-level controls (G_{vt-1}) remain the same as in equation 4.7 (see main text).

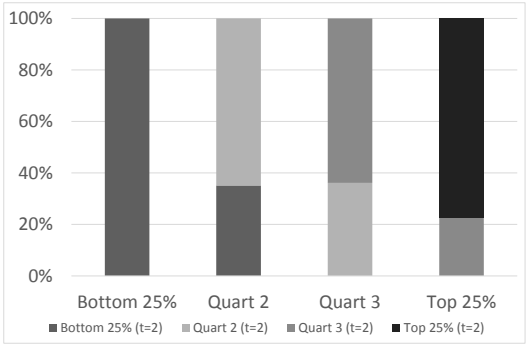
4.C Appendix C

Figure 4.C.2: Transition matrix by country

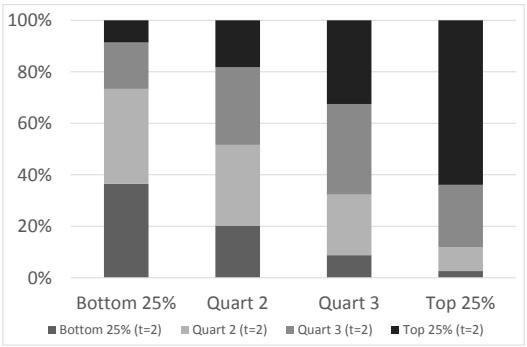
(a) Cambodia



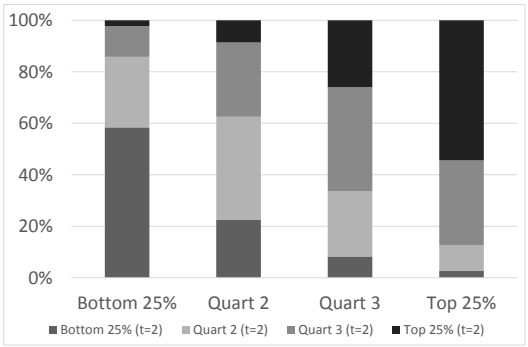
(b) Laos



(c) Thailand



(d) Vietnam



Note: [a]Differences between income sources are significant at the p<0.01 level according to two-sided t-tests except for resource extraction; [+]Purchasing Power Parity US Dollar to base year 2005.
Source: Authors' calculations.

Table 4.C.4: Descriptive statistics of households with and without shocks

Variables	Households without shock	Households with shock	Difference
Financial Capital			
Remittances in $US^{+}	1,472.66	1,224.26	248.4**
Access to insurance (1=yes)	0.85	0.78	0.0704***
Human Capital			
Household size	4.24	4.50	-0.258***
Number of children	1.31	1.47	-0.161***
Number of elderly	0.54	0.54	0.00411
Education household head (years)	5.33	5.11	0.220
Age household head (years)	53.12	52.26	0.852
Gender household head (1=female)	0.22	0.19	0.0328*
Natural Capital			
Land size in ha	2.26	2.23	0.0353
Livestock in TLU	0.21	0.24	-0.0241
Distance to forest in km$^{\#}$	2.99	3.03	-0.0362
Distance to water-body in km$^{\#}$	1.16	1.27	-0.103
Physical Capital			
Transportation assets in $US^{+}	3,349.96	2,727.78	622.2**
Agricultural assets in $US^{+}	140.49	159.45	-18.95
Household appliances in $US^{+}	800.63	684.91	115.7***
Size house in m^3	75.48	69.94	5.544***
Social Capital			
Communication assets in $US^{+}	113.49	89.19	24.30***
Ethnicity	0.83	0.82	0.0155
Membership political party	0.38	0.49	-0.107***
Income & Poverty			
Yearly income in $US^{+}	7,658.77	6,432.12	1,226.7***
Poverty (regional)^{o}	0.43	0.45	-0.0227
Poverty (international)^{ø}	0.23	31	-0.0750***
Observations	1,161	3,575	

Note: $^{+}$Monetary values are all given in Purchasing Power Parity US Dollar to base year 2005; $^{\#}$measured at village-level; ^{o}regional poverty lines apply - for details see Table 4.A.2; ^{ø}international poverty line of $1.90.
Source: Authors' calculations.

Table 4.C.5: Fixed-effects regression of households' income generating capacity

	(1)	(2)
Variables	Coef	Se
Log transportation assets	0.132***	(0.0390)
Log agricultural assets	-0.0794	(0.0550)
Log communication assets	0.00775	(0.0563)
Log household appliances	-0.0360	(0.0855)
Log land size	0.0300	(0.0737)
Log house size	-0.0944	(0.185)
Log Tropical livestock units	0.00440	(0.0480)
Log remittances	0.00426	(0.0301)
Education (years)	0.0789	(0.0579)
Squared log transportation assets	0.000511	(0.00166)
Squared log agricultural assets	0.00233	(0.00348)
Squared log communication assets	0.000968	(0.00413)
Squared log household appliances	0.00531	(0.00516)
Squared log land size	0.00806	(0.00621)
Squared log house size	0.0201	(0.0212)
Squared log Tropical Livestock Unit	-0.00330	(0.00355)
Squared log remittances	-0.00119	(0.00176)
Squared years of education	-0.00261	(0.00223)
Log transportation assets × log agricultural assets	3.70e-05	(0.00346)
Log transportation assets × log communication assets	-0.00206	(0.00293)
Log transportation assets × log household appliances	0.00125	(0.00396)
Log transportation assets × log land size	0.00180	(0.00391)
Log transportation assets × log house size	-0.0311***	(0.0106)
Log transportation assets × log TLU	0.00708***	(0.00228)
Log transportation assets × year of education	0.000418	(0.00230)
Log transportation assets × log remittances	-0.00293*	(0.00156)
Log agricultural assets × log communication assets	-0.00131	(0.00465)
Log agricultural assets × log household appliances	-0.00916*	(0.00519)
Log agricultural assets × log land size	-0.00286	(0.00586)
Log agricultural assets × log house size	0.0273**	(0.0134)
Log agricultural assets × log TLU	0.00342	(0.00350)
Log agricultural assets × year of education	0.00185	(0.00223)
Log agricultural assets × log remittances	0.00101	(0.00285)
Log communication assets × log household appliances	0.00509	(0.00608)
Log communication assets × log land size	0.00181	(0.00541)
Log communication assets × log house size	-0.000331	(0.0144)
Log communication assets × log TLU	-0.00441	(0.00401)
Log communication assets × log remittances	-0.00253	(0.00222)
Log communication assets × years of education	-0.00551*	(0.00308)
Log household appliances × log land size	0.00714	(0.00778)
Log household appliances × log house size	0.00255	(0.0201)
Log household appliances × log TLU	-0.00624	(0.00523)
Log household appliances × log remittances	0.000358	(0.00316)
Log household appliances × years of education	-0.00413	(0.00523)
Log land size × log house size	-0.0140	(0.0150)

Table 4.C.5 – continued from previous page

	(1)	(2)
Variables	coef	se
Log land size × log TLU	0.00744	(0.00478)
Log land size × log remittances	0.00207	(0.00278)
Log land size × years of education	-7.13e-05	(0.00427)
Log house size × TLU	-0.00795	(0.0109)
Log house size × log remittances	0.00523	(0.00666)
Log house size × years of education	-0.00412	(0.00997)
Log TLU × log remittances	-0.00233	(0.00192)
Log TLU × years of education	0.00335	(0.00339)
Log remittances × years of education	-0.000649	(0.00133)
Paved road	0.0211	(0.0407)
Violence	-0.0190	(0.0297)
Epidemics	0.137***	(0.0304)
Irrigation	-0.00320	(0.0252)
Share of households with access to electricity	0.0856**	(0.0427)
Wave	0.223***	(0.0180)
Constant	0.0146	(0.644)
Household fixed-effects	x	x
Observations	9,577	9,577
R^2	0.090	0.090
Number of households	4,881	4,881
Adjusted R^2	0.0827	0.0827
F-value	6.050	6.050
Root mean square error	0.466	0.466

Note: Robust standard errors in parenthesis. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Household controls: household size, number of children and elderly, education, membership political party, self-employment, off-farm employment, access to sanitation, drinking water and electricity; household head characteristics: age and gender; village characteristics: paved road, violence, epidemics, irrigation, average asset stock at baseline.
Source: Authors' calculations.

Table 4.C.6: Asset growth and shock type by country, marginal effect of interaction terms

Variables	(1) Asset growth	(2) Asset growth	(3) Asset growth	(4) Asset growth
Shock × Cambodia	-0.0323*	-0.0168		
	(0.0188)	(0.0162)		
Shock × Laos	-0.0110	-0.00438		
	(0.0124)	(0.0132)		
Shock × Thailand	-0.0196**	-0.00910		
	(0.00815)	(0.00754)		
Shock × Vietnam	-0.0156	-0.0147*		
	(0.00971)	(0.00862)		
Economic × Cambodia			-0.0224	-0.0117
			(0.0262)	(0.0231)
Economic × Laos			0.000676	0.00924
			(0.0234)	(0.0273)
Economic × Thailand			0.0125	0.00653
			(0.0124)	(0.0123)
Economic × Vietnam			-0.00301	-2.43e-05
			(0.0109)	(0.00950)
Health × Cambodia			-0.0148	-0.00433
			(0.0128)	(0.0117)
Health × Laos			-0.0190*	-0.0126
			(0.0110)	(0.0121)
Health × Thailand			-0.0213**	-0.0167**
			(0.00892)	(0.00841)
Health × Vietnam			-0.0156**	-0.00743
			(0.00769)	(0.00697)
Drought × Cambodia			-0.0278	-0.0195
			(0.0236)	(0.0228)
Drought × Laos			-0.0259*	-0.0201
			(0.0133)	(0.0158)
Drought × Thailand			0.00534	0.0123
			(0.00817)	(0.00773)
Drought × Vietnam			-0.0249***	-0.0212***
			(0.00855)	(0.00801)
Flood × Cambodia			-0.0308**	-0.0192
			(0.0133)	(0.0124)
Flood × Laos			0.00989	0.0104
			(0.0129)	(0.0141)
Flood × Thailand			0.00752	0.00997
			(0.0164)	(0.0135)
Flood × Vietnam			-0.0379***	-0.0431***
			(0.0144)	(0.0137)
Country fixed-effects	x	x	x	x
Shock probability	x	x	x	x
Household controls		x		x
Observations	4,686	4,686	4,686	4,686

Note: Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Household controls: household size, number of children and elderly, education, membership political party, self-employment, off-farm employment, access to sanitation, drinking water and electricity; household head characteristics: age and gender; village characteristics: paved road, violence, epidemics, irrigation, average asset stock at baseline.
Source: Authors' calculations.

Table 4.C.7: Asset growth by shock type and income quartile at country level, marginal effects

Variables	(1) Cambodia	(2) Laos	(3) Thailand	(4) Vietnam
Economic shock × Quart 1	0.00678	0.0365	0.00322	-0.00646
	(0.0346)	(0.0291)	(0.0345)	(0.0194)
Economic shock × Quart 2	0.0358	0.00213	-0.00512	0.0169
	(0.0354)	(0.0859)	(0.0308)	(0.0167)
Economic shock × Quart 3	-0.000560	-0.0207	0.0388*	-0.0182
	(0.0369)	(0.0479)	(0.0225)	(0.0152)
Economic shock × Quart 4	-0.121***	-0.00742	-0.0110	0.0148
	(0.0457)	(0.0335)	(0.0200)	(0.0250)
Health shock × Quart 1	-0.0270	-0.0254	-0.0172	8.74e-05
	(0.0191)	(0.0163)	(0.0216)	(0.0123)
Health shock × Quart 2	0.00640	-0.0121	0.0145	0.00906
	(0.0181)	(0.0266)	(0.0170)	(0.0128)
Health shock × Quart 3	0.00570	-0.00538	-0.00958	-0.00516
	(0.0255)	(0.0279)	(0.0150)	(0.0128)
Health shock × Quart 4	-0.00877	-0.0117	-0.0375**	-0.0339
	(0.0345)	(0.0267)	(0.0151)	(0.0209)
Drought shock × Quart 1	-0.0493	-0.0501**	0.0190	-0.00524
	(0.0335)	(0.0244)	(0.0212)	(0.0134)
Drought shock × Quart 2	-0.0420	-0.0216	0.0150	-0.0257
	(0.0319)	(0.0291)	(0.0153)	(0.0156)
Drought shock × Quart 3	-0.0660	0.00729	0.0222	-0.00908
	(0.0559)	(0.0324)	(0.0137)	(0.0147)
Drought shock × Quart 4	-0.103***	0.0156	-0.0111	-0.00662
	(0.0320)	(0.0294)	(0.0137)	(0.0194)
Flood shock × Quart 1	-0.0205	0.0142	-0.00678	-0.0351
	(0.0199)	(0.0189)	(0.0441)	(0.0246)
Flood shock × Quart 2	-0.0434**	-0.00857	-0.00949	-0.00508
	(0.0210)	(0.0286)	(0.0295)	(0.0309)
Flood shock × Quart 3	-0.0452	0.0110	0.0355	-0.0519**
	(0.0309)	(0.0256)	(0.0218)	(0.0242)
Flood shock × Quart 4	-0.0834**	0.00279	0.0101	-0.0703***
	(0.0369)	(0.0430)	(0.0223)	(0.0227)
Country fixed-effects	x	x	x	x
Shock probability	x	x	x	x
Household controls	x	x	x	x
Observations	484	470	1,872	1,860

Note: Marginal effects per country and shock type * quartile are displayed. Standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Household controls: household size, number of children and elderly, education, membership political party, self-employment, off-farm employment, access to sanitation, drinking water and electricity; household head characteristics: age and gender; village characteristics: paved road, violence, epidemics, irrigation, average asset stock at baseline.
Source: Authors' calculations.

4.D Appendix D

Table 4.D.8: Asset growth and unexpected shocks by country

Variables	(1) Asset growth	(2) Asset growth	(3) Asset growth	(4) Asset growth
USI × Cambodia	-0.0486	-0.0244		
	(0.0359)	(0.0361)		
USI × Laos	-0.0352	-0.000751		
	(0.0433)	(0.0469)		
USI × Thailand	0.0476*	0.0467**		
	(0.0245)	(0.0235)		
USI × Vietnam	-0.0552**	-0.0328		
	(0.0251)	(0.0226)		
EUSI × Cambodia			0.128	0.120
			(0.0920)	(0.0878)
EUSI × Laos			0.159*	0.200*
			(0.0964)	(0.110)
EUSI × Thailand			0.0312	0.0315
			(0.0245)	(0.0233)
EUSI × Vietnam			-0.0475	-0.0164
			(0.0302)	(0.0269)
HUSI × Cambodia			-0.00850	-0.00348
			(0.0169)	(0.0195)
HUSI × Laos			-0.0195	-0.00292
			(0.0225)	(0.0158)
HUSI × Thailand			-0.00248	-0.00684
			(0.0163)	(0.0244)
HUSI × Vietnam			-0.00923	-0.00678
			(0.0147)	(0.0154)
DUSI × Cambodia			-0.0101	-0.00328
			(0.0159)	(0.0155)
DUSI × Laos			-0.0114	-0.0130
			(0.00903)	(0.0110)
DUSI × Thailand			0.00900	0.00987
			(0.00653)	(0.00611)
DUSI × Vietnam			-0.0144**	-0.00603
			(0.00650)	(0.00585)
FUSI × Cambodia			-0.0337**	-0.0256**
			(0.0134)	(0.0126)
FUSI × Laos			0.00517	0.0118
			(0.0111)	(0.0131)
FUSI × Thailand			0.00928	0.0112
			(0.0107)	(0.00975)
FUSI × Vietnam			0.00784	-0.000258
			(0.00774)	(0.00715)
Country fixed-effects		x		x
Household controls		x		x
Observations	4,682	4,682	4,682	4,682

Note: Marginal effects per country and shock type * quartile are displayed. Standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1. Household controls: household size, number of children and elderly, education, membership political party, self-employment, off-farm employment, access to sanitation, drinking water and electricity; household head characteristics: age and gender; village characteristics: paved road, violence, epidemics, irrigation, average asset stock at baseline.
Source: Authors' calculations.

Table 4.D.9: First stage results

Variables	Shock	Economic	Illness	Drought	Flood
Mean assets (village-level)	0.684***	0.140**	-0.0202	0.133*	0.00466
	(0.265)	(0.0615)	(0.132)	(0.0787)	(0.0531)
Share households with shock (subdistrict-level)	1.520***				
	(0.446)				
Mean assets × Share households with shock	-0.726**				
	(0.342)				
Share households with economic shock		1.373**			
		(0.583)			
Mean assets × Share households with economic shock		-0.850*			
		(0.455)			
Share households with health shock			-0.185		
			(0.514)		
Mean assets × Share households with health shock			0.372		
			(0.392)		
Share households with drought shock				1.184***	
				(0.331)	
Mean assets × Share households with drought shock				-0.308	
				(0.255)	
Share households with flood shock					0.837**
					(0.408)
Mean assets × Share households with health shock					-0.251
					(0.309)
Constant	-0.538	-0.135*	0.395**	-0.154	0.129*
	(0.345)	(0.0803)	(0.174)	(0.105)	(0.0705)
Country fixed-effects	x	x	x	x	x
Observations	4,887	4,887	4,887	4,887	4,887
Adjusted R^2	0.0650	0.0181	0.0563	0.151	0.106
F-value	57.57	16.00	49.60	146.4	97.15
Root mean square error	0.420	0.289	0.433	0.372	0.260

Note: Robust standard errors in parentheses. Significance levels *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculations.

Chapter 5

Food security in rural Cambodia and fishing in the Mekong in the light of declining fish stocks

Key words: Cambodia, Fishing, Mekong River, Nutrition, Food security indicators
JEL classification: D12, D13, I25, J16

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Chapter 6

Eat your fish and sell it, too - Livelihood choices of small-scales fishers in rural Cambodia

Key words: Cambodia, Small-scale capture fishery, Sustainable Livelihood Framework, Livelihood strategies, Food security, Random-effects regression
JEL classification: D12, D13, I25, J16

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Chapter 7

Rural livelihoods and environmental resource dependence in Cambodia

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