Economic Transformation of Rural Livelihoods in South-East Asia

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Zusammenfassung

Trotz der erheblichen wirtschaftlichen Entwicklung Südostasiens in den vergangenen Dekaden bestehen zwischen Kambodscha, Laos, Thailand und Vietnam nach wie vor große ökonomische Unterschiede. Es gibt ein großes Wohlstandsgefälle zwischen der Stadtbevölkerung und Teilen der Landbevölkerung, deren Lebensgrundlage von der Ausbeutung natürlicher Ressourcen und der Landwirtschaft abhängt. Umweltveränderungen, insbesondere Umweltzerstörung und Klimawandel, können die Haushalte in der Erwirtschaftung ihres Lebensunterhalts stark einschränken – bis hin zum Auftreten von Nahrungsmittelknappheit. Gleichzeitig bietet die zunehmende Verbreitung von modernen Technologien wie Smartphones und der Zugang zum Internet ländlichen Haushalten viele neue Möglichkeiten, ihr Einkommensportfolio zu verbessern. Ausgerichtet auf die Haushaltsebene untersucht diese Dissertation in sechs Aufsätzen, wie Umweltveränderungen und neue Technologien ländliche Haushalte in Kambodscha, Laos, Thailand und Vietnam in ihren Lebensgrundlagen beeinflussen. Auf Basis von Ergebnissen empirischer Untersuchungen werden Vorschläge erarbeitet, wie Lebensgrundlagen angepasst und Entwicklungspolitik gestaltet werden können, sodass in Zukunft mehr Haushalte an der wirtschaftlichen Entwicklung teilhaben können und dabei in geringerem Maße von deren negativen externen Effekten betroffen sind.

Kapitel zwei beschäftigt sich mit den Lebensgrundlagen ländlicher Haushalte und deren Abhängigkeit von natürlichen Ressourcen mit dem Ziel, Belastungen dieser Haushalte durch Umweltzerstörung vorzubeugen oder zu reduzieren. Es werden die Einkommensquellen landwirtschaftlicher Haushalte in den ländlichen Gebieten Kambodschas ermittelt und deren Abhängigkeit von natürlichen Ressourcen untersucht. Basis hierfür sind Daten von 580 Haushalten in 30 Dörfern der Provinz Stung Treng in Kambodscha aus dem Jahr 2013. In einer zweistufigen Clusteranalyse, die Informationen über Aktivitäten zur Gewinnung von Einkommen auswertet, werden drei unterschiedliche Lebensgrundlagen-Segmente ländlicher Haushalte identifiziert. Außerdem werden Regressionsmodelle eingesetzt, um bestimmende Faktoren für die Zuordnung zu einem der Lebensgrundlagen-Segmente und deren Abhängigkeit von natürlichen Ressourcen herauszuarbeiten. Die Ergebnisse zeigen, wie unterschiedliche Arten von Kapital - zum Beispiel Umweltkapital, finanzielles Kapital oder Humankapital - Lebensgrundlagen determinieren. Natürliche Ressourcen machen einen signifikanten Anteil der Haushaltseinkommen aus (27%) und sind in der Lage, Einkommensungleichheiten zwischen Haushalten um 7% zu reduzieren. Das absolute Einkommen aus natürlichen Ressourcen ist positiv mit dem Gesamteinkommen korreliert, aber die relative Wichtigkeit von Einkommen aus natürlichen Ressourcen nimmt mit zunehmendem Einkommen ab. Das bedeutet, dass Haushalte mit niedrigen Einkommen nicht für Umweltzerstörung verantwortlich gemacht werden können, da sie nicht in der Lage sind, Aktivitäten mit hohen Erträgen auszuführen. Die Ergebnisse

zeigen außerdem, dass die Förderung von Jobs außerhalb der Landwirtschaft, von Bildung und von sozialen Netzwerken die Ausbeutung natürlicher Ressourcen reduzieren kann.

Kapitel drei nutzt Daten von 600 ländlichen Haushalten in Stung Treng, Kambodscha, aus den Jahren 2013 und 2014, um die aktuelle Ernährungssituation unter dem Aspekt des Fischfangs zu bewerten. Dazu werden Maße wie Energie- und Proteinaufnahme und Ernährungssicherungsindikatoren herangezogen. Quantitative Ergebnisse zeigen, dass Haushalte, die Fischfang betreiben, in der vergangenen Woche eine nährstoffreichere Ernährung hatten, mehr Einkommen aus Subsistenzaktivitäten generieren und weniger für zusätzliche Lebensmittel ausgaben. Außerdem berichten Haushalte aus dem unteren Einkommensquartil, die Fischfang betreiben, seltener von saisonaler Nahrungsmittelknappheit.

Kapitel vier nutzt die Ergebnisse der vorangegangenen Kapitel, um in Random-Effects Regressionsmodellen die Effekte von Einkommen aus kleinen Fischereien, das eine Form von Einkommen aus natürlichen Ressourcen darstellt, auf die Ernährungssicherung von Haushalten zu schätzen. Dazu wird das Konzept der nachhaltigen Lebensgrundlagen (‚Sustainable Livelihood Framework') erweitert, um die komplexe Verbindung zwischen ländlichen Einkommensportfolios und Ernährungssicherung unter separater Berücksichtigung von Monetär- und Subsistenzeinkommen aus allen wichtigen Haushaltsaktivitäten abbilden zu können. Durch die Berücksichtigung von Protein- und Kalorienaufnahme sowie anthropometrischer Daten werden alle vier Dimensionen der Ernährungssicherung beleuchtet. Die Ergebnisse unterstreichen die Wichtigkeit des Fischfangs für die Ernährungssicherung über alle Einkommensquartile im nördlichen Kambodscha: Die Lebensgrundlage von Haushalten in der unteren Hälfte der Einkommensverteilung hängt stark sowohl von Monetär- als auch Subsistenzeinkommen aus der Fischerei ab; Haushalte im höchsten Einkommensquartil haben den höchsten absoluten und relativen Fischkonsum. Daneben zeigen Ergebnisse der Kleinste-Quadrate Methode eine positive Verbindung zwischen Einkommen aus Fischerei und den anthropometrischen Daten von Kindern. Vor dem Hintergrund möglicherweise schrumpfender Fischbestände zeigen die Ergebnisse der Analysen, dass es gerade für arme Haushalte, deren Lebensgrundlage am stärksten von Fisch abhängt, derzeit kaum Alternativen zum Fischfang gibt. Daher rufen wir Entscheidungsträger dazu auf, die Situation der ökonomisch verwundbarsten Gruppen in Gegenden, die stark von der Fischerei abhängen, zu beachten, wenn Entscheidungen getroffen werden, die möglicherweise Auswirkungen auf Fischbestände oder Fischereien haben könnten. Außerdem kann eine Förderung von Einkommensaktivitäten, die Einkommen aus Fischfang ergänzen oder ersetzen, ein nachhaltiges Management von Fischbeständen erleichtern, natürliche Ressourcen schonen und gleichzeitig wachsender Ernährungsunsicherheit vorbeugen.

Eine weitere Quelle für Belastungen der Existenz ländlicher Haushalte sind Extremwetterereignisse, wie Sturm, Dürre und Überschwemmungen. Im Zuge des Klimawandels wird erwartet, dass deren Häufigkeit in Zukunft noch weiter zunehmen wird. Lokale Maßnahmen auf Haushalts- oder Dorfebene zur ex-ante Risikominderung könnten Belastungen durch Extremwetterereignisse vorbeugen und eventuell sogar einen Weg zur Anpassung an den Klimawandel bedeuten. In Kapitel fünf wird auf Basis von Paneldaten aus dem ländlichen Vietnam mit Beobachtungen aus über 1900 Haushalten aus den Jahren 2002 bis 2013 ein Difference-in-Differences Modell angewendet, um zu untersuchen, ob Maßnahmen zur Risikominderung effektiv die Anzahl der berichteten Belastungsereignisse oder deren Schaden verringert. Wir untersuchen außerdem, ob Maßnahmen zur Risikominderung Einkommen und Konsum von Haushalten nach einem ökonomischen Schockereignis durch Extremwetter verbessern. Unsere Ergebnisse zeigen, dass Haushalte mit Risikominderungsstrategien über geringere Schäden durch Dürre berichten und ein höheres Konsumniveau sogar nach einem Schockereignis halten können. Eine Förderung von individuellen Maßnahmen zur Risikominderung kann zwar oft nicht den Einfluss von Extremwetterereignissen auf die Einkommensquellen des Haushalts verringern helfen, aber durch ein höheres Einkommen und einen höheren Konsum kann sich die allgemeine Resilienz der Haushalte erhöhen.

Kapitel sechs und sieben beschäftigen sich mit den Möglichkeiten, die die schnelle Verbreitung von Smartphones in Entwicklungsländern mit sich bringen. Die drahtlose Technologie, die nur ein Minimum an Infrastruktur benötigt, ist prädestiniert, ländliche Regionen in Entwicklungsländern mit Telekommunikation und Internet zu versorgen. Die verbesserten Kommunikationsmöglichkeiten verringern Transaktionskosten, zum Beispiel beim Kauf oder Verkauf landwirtschaftlicher Erzeugnisse oder Dienstleistungen, wie dem Pflügen eines Feldes. Außerdem verbessern sie den Zugang von ländlichen Haushalten zu Finanzdienstleistungen und Arbeitsmärkten. Mittels Daten aus Kambodscha, Laos, Thailand und Vietnam zeigt Kapitel sechs, dass Smartphones das Haushaltseinkommen erhöhen können. Dabei wird mit einem Endogenous Treatment Modell für die Endogenität von Smartphones in den statistischen Modellen kontrolliert. Zahlreiche Robustheitschecks bestätigen das Ergebnis. Kapitel sieben führt das Thema weiter und verwendet eine ähnliche Methodik, um den Einfluss von Smartphones auf die Arbeitsmobilität zu untersuchen. Die Ergebnisse zeigen, dass der Besitz eines Smartphones die Wahrscheinlichkeit erhöht, Pendler zu sein, die Wahrscheinlichkeit für Arbeitsmigration aber verringert. Das führt zu dem Schluss, dass Investitionen in moderne Kommunikationstechnologien auf Haushaltsebene und öffentliche Investitionen in Telekommunikationsinfrastruktur Haushalten dabei helfen können, ihre Einkommensportfolios und Lebensgrundlagen an Umweltveränderungen und neue Möglichkeiten anzupassen.

Schlagworte: Ökonomische Entwicklung, Süd-Ost Asien, Umweltökonomik, ländliche Lebensgrundlagen, Verbreitung neuer Technologien

Abstract

Despite rapid economic development in South-East Asia in the past decades there is still great economic heterogeneity between Cambodia, Laos, Thailand, and Vietnam. A welfare gap exists between urban populations and parts of the rural population who remain dependent on agriculture and natural resource extraction. Changes in the environment, namely environmental resource degradation and climate change, can expose their livelihoods to severe pressure, including incidences of food insecurity. At the same time, the spread of modern technology in the form of smartphones and access to the internet opens up reams of opportunities to rural households to improve their income-earning portfolio. Focusing at the household level, this dissertation identifies how these processes affect rural households in Cambodia, Laos, Thailand and Vietnam based on their livelihood strategies in six different essays. It uses these findings to generate ideas how rural livelihoods could be transformed and how development policies could be adjusted so that in the future more households will benefit from the rapid economic development in South-East Asia and avoid to be negatively affected by its external effects.

Chapter two seeks to gain understanding about rural livelihood strategies and environmental resource dependence to help reduce and prevent livelihood stress induced by environmental resource degradation. It identifies livelihood strategies of farm households in rural Cambodia and explores their determinants with a focus on environmental resource dependence. The data are derived from a survey of 580 households in 30 villages of Stung Treng province in Cambodia undertaken in 2013. An activity-based two-step cluster analysis identifies different livelihood clusters and regression models analyze major factors affecting the choice of livelihood strategies and their dependence on environmental resources. The results demonstrate how different levels of capital, e.g. environmental capital, human capital, financial capital, influence livelihood strategies. Environmental resources contribute a significant portion of household income (27%) and act as a means to reduce income inequality (7%) among households. Absolute environmental income is positively correlated with total income but the relative environmental income decreases with an increase in total income. Thus, it appears that low income households are not to be blamed for environmental degradation, because they are unable to undertake activities with high returns. The findings further suggest that promoting off-farm employment, education and social networking reduces the extraction of environmental resources.

Chapter three uses data on 600 rural households in Cambodia collected in two waves in 2013 and 2014 in the province of Stung Treng to assess the current situation of food security in relation to fishing. To proxy food security, it considers energy and protein intakes as well as Food Security Indexes. Quantitative results show that fishing households had a more nutritious diet in the past week, are

more engaged in subsistence activities and had lower additional food expenditure. Furthermore, fishing is effective in reducing seasonal food insecurity for households in the lowest income quartile.

Chapter four utilizes the findings from the previous chapters to analyze the effects of income from small-scale capture fishery, a form of environmental income, on household food security in random effects models. It extends the sustainable livelihood framework to depict the complex relationship between rural livelihood portfolios and food security by distinguishing in-kind income and cash income from all important household activities. Considering protein and calorie intake alongside with anthropometric data it sheds light onto all four dimensions of food security. The results underline the importance of fishery for food security across all income quartiles in northern Cambodia. Households in the lower half of the income distribution crucially depend on home consumption and income generated from fishing; households in the highest income quartile have the highest absolute and relative protein intake from fish. Furthermore, we establish a positive connection between small-scale capture fishery and child anthropometrics in Ordinary Least Square models. Against the background of potentially declining fish stocks we find that there are currently hardly any alternatives to fishing for poorer households, who are most dependent on capture fishery. We hence urge policy-makers to especially consider the most vulnerable groups in fishery communities when making decisions on rural development potentially affecting fish stocks and fishery. By supporting livelihood activities that supplement fishing income, policy-makers could enhance sustainable fish stock management, help conserve natural resources and simultaneously prevent growing food insecurity.

Another common source of livelihood stress in rural households in developing countries is extreme weather events which are expected to become more frequent due to climate change. Local action for ex-ante risk mitigation strategies could reduce livelihood stress due to extreme weather and perhaps even mean a way to adapt to climate change. In chapter five a difference-in-difference model is applied to panel data from rural Vietnam containing information on more than 1900 households from 2002 to 2013 to investigate whether risk mitigation is effective in reducing the number of extreme weather events causing livelihood stress and their damage. Furthermore, we ask if mitigation measures improve income and consumption of households after they experience a shock. Our results show that risk mitigators have reduced damage due to drought, increase their annual income and consumption in the absence of shocks and maintain higher consumption even after experiencing a shock. Encouraging individual risk mitigation measures may hence not directly improve the households' situation of dealing with extreme weather, but through improved income and consumption households may improve their resilience to extreme events in terms of consumption levels.

Chapter six and seven deal with the opportunities of the rapid spread of smartphones in developing countries. Their independence of landline networks qualifies them for communication and internet

access in rural areas of developing countries in the absence of a well-developed infrastructure. Enhanced communication reduces households' transaction costs when accessing markets for purchase or sale of agricultural goods, or offering and buying services such as plowing fields. Furthermore, it may ease households' access to finance and the labor market. Drawing upon data from rural households in Cambodia, Laos, Thailand, and Vietnam, chapter six provides empirical evidence for smartphones' contribution to households' income after accounting for endogeneity of smartphone ownership in an endogenous treatment regression model and various robustness checks. Chapter seven takes this idea further and applies a similar methodology to the question if information flows through smartphones have an effect on labor mobility. The findings are that smartphone ownership increases labor mobility measured as the probability to be a commuter whereas it seems to discourage labor emigration. These findings lead to the conclusion that household level investment into modern communication technologies and public investment into infrastructure may help households adjust their income portfolios and livelihood strategies in reaction to environmental changes and new opportunities.

Keywords: Economic Development, South-East Asia, Environmental Economics, Rural Livelihoods, Technology Adoption

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List of Abbreviations

ASEAN	Association of Southeast Asian Nations
ATE	Average Treatment Effect
CDRI	Cambodian Development Research Institute
cf.	compare
CPI	Consumer Price Index
CSI	Coping Strategies Index
DiD	Difference in Differences
Eds.	Editors
ETR	Endogenous Treatment Regression
FAO	Food and Agriculture Organization
FCS	Food Consumption Score
FGD	Focus Group Discussions
GDP	Gross Domestic Product
GFK	Gesellschaft für Konsumforschung
HFIAS	Household Food Insecurity Access Scale
ICLARM	International Center for Living Aquatic Resources Management
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
IPWRA	Inverse-Probability Weighted Regression
ISPONRE	Institute of Strategy and Policy on Natural Resources and Environment
Lao PDR	Lao People's Democratic Republic
ML	Maximum Likelihood
NCDD	National Comittee for Sub-National Democratic Development
NIS	National Institute of Statistics (Cambodia)
OECD	Organization for Ecnomic Co-operation and Development
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
PPP	Purchasing Power Parity
PPS	probabilities proportional to size
rCSI	reduced Coping Strategies Index
SLF	Sustainable Livelihood Framework
TLU	Tropical Livestock Units
UN	United Nations
USAID	United States Agency für International Development
VIF	Variance Inflation Factor
WCED	World Comission on Environment and Development
WHO	World Health Organization
WTO	World Trade Organization

1 Introduction

1.1 Relevance of my research in development economics

In the past decades, the countries in the Greater Mekong Subregion[1], Cambodia, Laos, Thailand, and Vietnam have been undergoing rapid economic development and decreasing poverty levels (World Bank, 2014, 2016a, 2016b; United Nations, 2015; OECD, 2013; Bertelsmann Stiftung, 2016a, 2016b, 2016c, 2016d). Even though there is still great economic heterogeneity between the different states, their economic development continues to rapidly improve access to infrastructure and increases the standard of living of its population year by year. Among the important factors that have improved are access to electricity, sanitation, education, health care, and modern technologies such as cell phones (World Bank, 2014, 2016a; The Economist, 2014; United Nations, 2015; Vietnam Academy of Social Sciences, 2011; Tong and Sry, 2013).

Yet, despite the fast pace of economic development, a stark contrast in economic power and welfare between rural and urban areas stays evident throughout the region (Amare et al., 2012; United Nations, 2015; Thu Le and Booth, 2014). Livelihoods in rural areas remain heavily dependent on agriculture and natural resource extraction (World Bank, 2014, 2016a; United Nations, 2015). Despite rapid improvements, malnutrition and food insecurity are still common issues (United Nations, 2015; Santacroce, 2008; Waibel and Hohfeld, 2016). Furthermore, natural resource degradation as a consequence of population growth and economic development as well as climate change threaten rural livelihoods in their present structure (Ananta et al., 2013; United Nations, 2015; Tong and Sry, 2013). There is hence a need to identify the challenges of the ongoing changes to raise awareness of winners and potential losers in the course of economic development and climate change and to identify channels through which households may benefit equally from new opportunities.

Environmental resources provide a variety of life-supporting ecosystem services to rural households in developing countries, for example forest products and fish (Babulo et al., 2009; Buehler et al., 2015; Nguyen and Tenhunen, 2013; Thondhlana et al., 2012). Their extraction is often considered an

[1] Our survey provinces are Stung Treng in Cambodia, Savannakhet in Laos, Buri Ram, Nakhon Phanom, and Ubon Ratchathani in Thailand, Ha Thinh, Thua Thien Hue, and Dak Lak in Vietnam. Out of these, the two Vietnamese provinces of Ha Tinh and Thua Thinh Hue are geographically not part of the Lower Mekong River Basin. However, since the political and economic circumstances are very similar to the other provinces we nevertheless use their data in our studies and treat them like the other provinces, referring to the Greater Mekong Subregion.

important source of income and a means of livelihoods for low income rural households (Jansen et al., 2006; Kamanga et al., 2009; Naidu, 2011; Schaafsma et al., 2014). However, in many parts of the world, environmental resources are threatened to be degraded (Beck and Nesmith, 2001; World Commission on Environment and Development, 1987; Freeman, 2014). Understanding rural livelihood strategies and environmental resource dependence can help reduce and prevent livelihood stress induced by the degradation of environmental resources during the development process, especially for low income households (Babigumira et al., 2014; Sherbinin et al., 2008).

Fishing is a form of environmental extraction that is considered especially important for the food security of the poor because fish is easily accessible and rich in proteins and micronutrients (Aiga et al., 2009; Belton and Thilsted, 2014; Hortle, 2007; Kawarazuka and Béné, 2010, 2011). However, in many regions worldwide there is concern that fish will not continue to play this role in the future: Demand for fish is increasing and natural fish stocks are under pressure. Important factors are overexploitation of fish resources, climate change and changing ecosystems, e.g. due to the construction of dams (Béné et al., 2016; Cowx et al., 1998; Grote, 2014; Welcomme et al., 2010). Particularly small-scale capture fishery communities in Africa and Asia could suffer from declining fish stocks (Welcomme et al., 2010). A thorough understanding of income portfolios in these communities with a focus on food security is needed to adapt fishers' livelihoods to the situation. Alternative livelihood strategies may not completely replace fishing, but combined with other resource management practices they may support existing rural livelihoods and help conserve environmental resources (Martin et al., 2013). By supporting livelihood activities that supplement fishing income, policy-makers could enhance sustainable fish stock management and simultaneously prevent growing food insecurity.

Another frequent cause of livelihood stress for rural households in developing countries are extreme weather events, such as droughts, floods and storms (Rayhan and Grote, 2010; Tongruksawattana et al., 2013; Waibel et al., 2013; Ziervogel and Calder, 2003). Dependency on agriculture and natural resources as part of their income portfolio exposes these households to risk of facing adverse weather shocks. At the same time they are most vulnerable to extreme weather events because they often have a limited capacity to cope with shocks due to lack of physical resources, entitlements and skills (Devereux, 2001). Extreme weather events are expected to become even more frequent in the future due to climate change (Intergovernmental Panel on Climate Change, 2012). This will disproportionally affect rural populations of developing countries as they are most vulnerable to extreme weather and their adaptive capacity to increasing risk is low (Adger et al., 2006). They are further disadvantaged since institutional support in adaptation to climate change is important but especially developing countries often have weak governance systems (Adger, 2000; Aron, 2000).

Under these circumstances investment into household- and village-level measures which are effective in reducing risk to be adversely affected by extreme events could be an important strategy for rural households to improve their situation. There is evidence that risk awareness and consequently risk mitigation is often related to recent shock experience (Bryan et al., 2009; Waibel et al., 2013). Despite this rather short time horizon, the ability of rural households to mitigate observed risks may nevertheless form an autonomous and spontaneous path of adaptation to climate change (Burton, 1997; Smit et al., 2001; Smithers and Smit, 1997). Hence, investigating the effect of risk mitigation measures is not only helpful in determining their short- and medium term impact but also in understanding if they may be useful in adapting to long-term climate change.

However, the changing environment does not only pose risks to rural households, it also provides opportunities. The worldwide spread of mobile phones has been an unprecedented technological success story, promising to improve rural livelihoods by easing flows of information. The literature has identified efficiency gains via mobile phone-based information exchange, for example information about market prices (Aker, 2010; Jensen, 2007; Tadesse and Bahiigwa, 2015). The second generation of mobile devices, particularly smartphones, enables mobile access to the information universe and the use of software applications ('apps'). Their independence of landline data networks and electricity grids qualifies them especially for internet access in remote rural areas of developing countries. Internet-based information about products, prices and economic policy is relevant for business and private use, information about the weather is essential for agriculture, and information about vacant jobs helps job seekers. Compared to regular mobile phones, smartphones extend the possibilities of carrying out financial transactions and offering or purchasing goods or services. Today already half of the world's adult population owns a smartphone, while forecasts reckon that by 2020 this number will increase to eighty percent (The Economist, 2015). The question whether these advantages of smartphones contribute to rural techno-economic development, e.g. by changing income-earning portfolios or labor markets, remains an open one.

Focusing at the household level, this dissertation identifies how some of these highly dynamic processes affect rural households in the countries of the Greater Mekong Subregion based on their livelihood strategies. It uses these findings to generate ideas how rural livelihoods could be transformed and how development policies could be adjusted so that in the future more households benefit from the rapid economic development in South-East Asia and avoid to be affected by its external effects.

1.2 Research Objectives

The main aim of this dissertation is to generate insights into which sources of income rural households in the countries of the Greater Mekong Subregion depend on, how these affect their food security and how households successfully transform their livelihoods to adapt to the rapidly changing natural, economic and technological environment in the area. The focus lies on the challenges rural households face, such as extreme weather events, climate change and environmental degradation, but also on the potential opportunities of new technologies, namely smartphones. Specifically, the following research questions and objectives are addressed:

1) Focusing on environmental resource extraction, what are the livelihood strategy segments of rural households in Cambodia and how are they determined? How much is their environmental income and how is it distributed? What are the determinants of environmental resource extraction?

2) How much do fishing activities influence the diets of fishers in comparison to non-fishers in Cambodia? Is fish of greater importance in the food security of poorer households than in others? How can the other typical income-earning strategies of fisher's households be characterized?

3) What is the effect of in-kind income from fishing on household food consumption after controlling for all other sources of in-kind income and cash food expenditure? What is the effect of cash income from fishing on household food expenditure after controlling for all other sources of cash income? Which livelihood activities complement fishing and which substitute for fishing? How are capture fishery, food consumption and child anthropometrics related? How does the importance of fish vary along the income distribution?

4) Can rural households in Vietnam improve their welfare by taking risk mitigation measures against extreme weather events? Are households better off because they reduce the threat to be affected by specific risks or because they improve their generic capacity to deal with economic shocks?

5) Do smartphones contribute to rural techno-economic development in South-East Asia by increasing rural households' annual income?

6) Does smartphone ownership enhance local labor market participation and labor mobility in South-East Asia?

1.3 Structure of the dissertation

This dissertation consists of seven chapters. Chapter one introduces the main topic and explains how the other chapters relate to this topic and to each other. Chapter two identifies different livelihood strategies of rural households in Cambodia with a special focus on the role of environmental resource

extraction. It provides the foundation for understanding which role extraction plays in different livelihood strategies and identifies the determinants of livelihood strategy choices and environmental resource dependence. In this chapter, principal component and cluster analysis are applied to data from Cambodia, resulting in three livelihood strategy segments: One cluster with low-skilled non-permanent wage employment and farming, another with environmental resource extraction and farming and a third one with high-skilled wage employment, businesses and farming. A multinomial logit regression provides insights to which factors determine which livelihood strategy a household chooses depending on the capitals (natural, human, physical, financial and social capital) it owns. Lastly, a Tobit type II model gives insight to the determinants of participation in extraction activities and to the factors explaining the amount of environmental income a household extracts. Essentially, less affluent, less educated households with less natural capital are part of the first cluster, while more educated, more affluent households are more likely to be part of the third cluster. Households in the second cluster are more often part of an ethnic minority, have better access to environmental resources and own more physical capital for resource extraction. The results further indicate that more affluent households benefit absolutely more from resource extraction as they undertake activities with higher returns, whereas poorer households depend relatively more on environmental resources.

Chapter three analyzes data from Cambodia to show how fishing, the most important natural resource extraction activity, is related to households' diets and food security. As a result of ecosystem changes, fish stocks in the Mekong River are expected to decline. Using data on 600 rural households collected in two waves in 2013 and 2014 in the province of Stung Treng, the current situation of food security in relation to fishing is assessed. To proxy food security, we consider energy and protein intakes as well as Food Security Indexes. Descriptive results show that fishing households had a more nutritious diet in the past week, are more engaged in subsistence activities and had lower additional food expenditure. Furthermore, fishing is effective in reducing seasonal food insecurity for households in the lowest income quartile. In the light of declining fish stocks these findings underscore the need for fishing households to adjust their income earning activities to the expected changes. We call for policy-makers to account for the most fish-dependent groups of the population when designing or adjusting development policies for the area that could potentially affect fish stocks.

Chapter four uses the findings from the previous two chapters to quantitatively identify the effect of fishing income on food security while differentiating between in-kind and cash income from fishing and controlling for the income from other livelihood activities. The results of random effects regressions underline the importance of fishing for food security across all income quartiles in

Table 1 List of papers included in the dissertation.

Chapter	Authors	Title	Published in / Submitted to / Presented at
2	Nguyen, T. T., Do, T. L., Bühler, D., Hartje, R., and Grote, U. (2015)	Rural livelihoods and environmental resource dependence in Cambodia	Published in: *Ecological Economics (2015)*, 120, 282-295
3	Hartje, R., Bühler, D. and Grote, U. (2016)	Food Security in Rural Cambodia and Fishing in the Mekong in the Light of Declining Fish Stocks	Published in: *World Food Policy* (2016), 2 (2) / 3 (1), 5 - 31 Presented at the 2015 International Conference on World Food Policy in Bangkok, Thailand, December 17 - 18, 2015 Presented at Tropentag 2015 held at Humbold University zu Berlin, September 16 - 18 , 2015
4	Hartje, R., Bühler, D. and Grote, U.	Eat your fish and sell it, too – Livelihood choices of small-scale fishers in rural Cambodia	Published in: *Ecological Economics* (2018), 154, 88-98 Presented as 'How Fishing and other livelihood activities explain food consumption. The Case of Cambodia.' at PEGnet Conference 2016 in Kigali, Rwanda, September 15 - 16, 2016
5	Hartje, R. and Grote, U.	Do risk mitigation strategies help rural households in Vietnam reduce the impact of extreme weather events?	Presented at the annual conference 2016 "Development Economics and Policy" of Ausschuss für Entwicklungsländer (AEL) of Verein für Socialpolitik in Heidelberg, June 03-04, 2016 Presented at the workshop “Climate Change Debates, Policies and Economics – Vietnam and Beyond” in Roskilde, Denmark, May 3- 4, 2015 Presented at PEGnet Conference 2015 in Berlin, October 8 -9, 2015 Presented at Tropentag 2015 held at Humbold University zu Berlin, September 16 - 18 , 2015 Presented at the 6th EAAE PhD Workshop in Rome, Italy, June 8-10, 2015 Presented at the International Conference on Globalization and Development (GLAD) in Göttingen, May 11 - 12, 2015
6	Hübler, M. and Hartje, R. (2016)	Are Smartphones Smart for Economic Development?	Published in: *Economics Letters* (2016), 141, 130-133 Hartje, R. and Hübler, M. (2015): Are Smartphones Smart for Economic Development?, Hannover Economic Papers, No. 555, School of Economics and Management, Hanover.
7	Hartje, R. and Hübler, M. (2017)	Smartphones Support Smart Labor	Published in: *Applied Economics Letters* (2017), 24 (7), 467-471 Presented at the annual conference 2016 "Development Economics and Policy" of Ausschuss für Entwicklungsländer (AEL) of Verein für Socialpolitik in Heidelberg, June 03-04, 2016 Hübler, M. and Hartje, R. (2015): Smart Phones support Smart Labor, Hannover Economic Papers, No. 559, School of Economics and Management, Hanover.

Note: Chapter two to seven are the result of co-authorships. To chapter two the author has contributed through data collection and cleaning, developing large parts of the econometric strategy (except Principal Component Analysis and Cluster Analysis), giving advice on dealing with econometric issues, writing chapters 3.2 and 3.3.2 as well as revision in the publication process. Chapter three is mainly developed, researched and written by the author of this dissertation, except for the chapter on measuring food security which is written by Dorothee Bühler. Ulrike Grote and Dorothee Bühler have further supported the paper by proof-reading and giving advice on the text. Chapter four is also mainly developed, analyzed and written by the author of this dissertation, while Dorothee Bühler and Ulrike Grote have supported the paper through peer reviews and during the proof-reading process. Dorothee Bühler has furthermore contributed the data on child anthropometrics and wrote the paragraph on the construction of child anthropometric indicators. Chapter five is the result of Ulrike Grote’s idea to apply the dataset to issues of climate change and the author’s development of research questions and methodology, data analysis as well as writing. Ulrike Grote has given advice on the text in several iterations of proof-reading. To chapter six the author has contributed the idea for the paper, the dataset, including the construction of the smartphone variables, writing the appendix on smartphone identification, development of the econometric strategy and extensive advice on analytical issues. Chapter seven is the result of Michael Hübler’s idea to apply the smartphone variables to the issue of labor markets, doing the main analysis and writing the main paper. The author has contributed the data, defined and elaborated the smartphone variables, developed the methodology, analyzed the data for robustness checks and wrote the respective chapters in the appendix.

northern Cambodia. Households in the lower half of the income distribution crucially depend on home consumption and income generated from fishing; households in the highest income quartile have the highest absolute and relative protein intake from fish. Furthermore, a positive connection between small-scale capture fishery and child anthropometrics is established. Against the background of potentially declining fish stocks the findings suggest that currently there are hardly any alternatives to fishing for poorer households, which are most dependent on capture fishery.

Chapter five asks how households with agricultural income in Vietnam benefit when undertaking risk mitigation measures against extreme weather events, namely flood, drought and storm. The underlying rationale is that positive effects of rather short-term focused risk mitigation measures could lead to a long-term path of adaptation of climate change. Results of difference-in-differences analyses show that mitigation measures have a very limited capacity to reduce the immediate impact of extreme events on households. The findings show that risk mitigators have reduced damage due to drought but do not report significant effects with regards to the number of shocks they experience or damage due to storms or flooding. Still, mitigation measures seem to improve households' generic capacity to adapt by increasing their annual income and consumption in the absence of shocks and maintain higher consumption even after experiencing a shock.

Chapter six deals with the effect of smartphone ownership on rural households' income as an example of technology diffusion. We construct a variable that identifies smartphones among mobile phones owned by households, depending on its value and time of purchase. This variable is then used in an endogenous treatment regression and various robustness checks show if Smartphone owners are able to improve their income after controlling for endogeneity of smartphone ownership. Besides a statistically highly significant income effect of smartphones the results show that household size and occupation are important factors determining smartphone ownership.

Chapter seven takes the smartphone topic further by asking if smartphones enhance labor market participation, for example by improving communication, supporting information flows and financial transactions. A similar methodology as in chapter six and numerous robustness checks show that smartphones are connected to increased labor market participation in local jobs and jobs that require commuting, i.e. working outside the village during the day and returning at night. In contrast, they seem to discourage labor migration, i.e. jobs that require permanent absence from the household.

Table 1 gives an overview of all the papers included in the dissertation, earlier versions of them and where they were presented. Additionally, there are two more papers which are related to this dissertation but not presented here to which the author contributed smaller parts. These are:

Bühler, D., Grote, U., Hartje, R., Ker, B., Lam, D. T., Nguyen, L. D., Nguyen, T. T. and Kimsun Tong (2015). *Rural livelihood strategies in Cambodia: Evidence from a household survey in Stung Treng.* ZEF Working Paper Series, No. 137, Center for Development Research (ZEF), Bonn.

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2 Rural Livelihoods and Environmental Resource Dependence in Cambodia

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3 Food Security in Rural Cambodia and Fishing in the Mekong in the Light of Declining Fish Stocks

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4 Eat your Fish and Sell it, too – Livelihood Choices of Small-scale Fishers in Rural Cambodia

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5 Do Risk Mitigation Strategies help Rural Households in Vietnam Reduce the Impact of Extreme Weather Events?

Abstract

Extreme weather events frequently cause livelihood stress in rural households in developing countries and they are expected to become more frequent due to climate change. Local action for ex-ante risk mitigation strategies could reduce livelihood stress due to extreme weather and perhaps even mean a way to adapt to climate change. We apply a difference-in-differences model to panel data from rural Vietnam containing information on more than 1900 households from 2002 to 2013 to investigate whether risk mitigation is effective in reducing livelihood stress and damage due to extreme events. Furthermore, we ask if mitigation measures improve income and consumption of households after they experience a shock. Our results show that risk mitigators have reduced damage due to drought, increase their annual income and consumption in the absence of shocks and maintain higher consumption even after experiencing a shock.

Keywords: Climate Change Adaptation; Risk Mitigation; Extreme Weather Events; Household Level; Vietnam; Difference in Differences

JEL code: I31, Q12, Q54, R11

5.1 Introduction

Extreme weather events, such as droughts, floods and storms are a frequent cause of livelihood stress for rural households in developing countries (Ziervogel and Calder 2003, Rayhan and Grote 2010, Tongruksawattana et al. 2013, Waibel et al. 2013). Dependency on agriculture and natural resources as part of their income-generating activities exposes these households to risk of facing adverse weather shocks. At the same time they are most vulnerable to extreme weather events because they often have a limited capacity to cope with shocks due to lack of physical resources, entitlements and skills (Devereux 2001). Extreme weather events are expected to become even more frequent in the future due to climate change (IPCC 2012). This will disproportionally affect rural populations of developing countries because they are most vulnerable to extreme weather and their adaptive

capacity to increasing risk is low (Adger et al. 2006). They are further disadvantaged since institutional support in adaptation to climate change is important but especially developing countries often have weak institutions (Adger 2000, Aron 2000).

Under these circumstances investment into household- and village-level measures which are effective in reducing risk to be adversely affected by extreme events could be an important strategy for rural households to improve their situation. To undertake risk mitigation measures, households need to be aware of the risk they are facing, they need to be able to assess these risks correctly and they need knowledge about potential risk mitigation measures. There is evidence that risk awareness and consequently risk mitigation is often related to recent shock experience (Bryan et al. 2009, Waibel et al. 2013). Despite this rather short-term time horizon, the ability of rural households to mitigate observed risks may nevertheless form an autonomous and spontaneous path of adaptation to climate change (Burton 1997, Smithers and Smit 1997, Smit et al. 2001). Hence, investigating the effect of risk mitigation measures is not only helpful in determining their short- and medium-term impact but also in understanding if they may be useful in adapting to long-term climate change.

Vietnam is especially suitable to study this as it is among the nations hit hardest by climate change (McElwee 2010). Its geographical features, namely the setting near the equator with a long coastline on one side and an equally long chain of mountains on the other, make it prone to increased damage by tropical cyclones (Cruz et al. 2007), increasingly heavy rainfall during the monsoon season and more frequent droughts during the dry season (ISPONRE 2009, World Bank 2010). Even though the share of agriculture in GDP is below 20% and further declining, 70% of the rural households are employed in agriculture and the sector remains an economic safety net for many of these households (World Bank 2012).

The existing literature describes numerous cases in which rural households in developing countries apply ex-ante risk mitigation strategies (Thomas et al. 2007, Bryan et al. 2009, Deressa et al. 2009, Gbetibouo et al. 2010). Evidentially, strategies such as agricultural diversification or soil and water conservation have an overall positive influence on rural households, e.g. in terms of farm productivity or consumption (Di Falco et al. 2011, 2012, Praneetvatakul et al. 2013). According to Eakin et al. (2014), there are two kinds of capacities to adapt to climate change. On the one hand, generic capacity to adapt to climate change is the result of higher or more stable income, improved access to credit and any other change that results in better human development and consequently in higher resilience, while on the other hand specific capacity reduces the effect of particular threats, e.g. a dike reduces the impact of a flood. With regards to the findings by Di Falco et al. (2011, 2012) and Praneetvatakul et al. (2013) it remains unclear if these positive findings are general income and consumption effects

in the absence of extreme events or whether they actually improve household capacities to deal with extreme events. We hence ask if households are able to improve their situation by taking risk mitigation measures and if these households are better off because they reduce the threat to be affected by specific risks or because they improve their generic capacity to deal with economic shocks.

We make use of a unique dataset from rural Vietnam containing information on more than 1900 households, tracing their experience of economic shocks due to extreme weather from 2002 to 2013. Using difference-in-differences models we measure if households applying risk mitigation strategies experience less shocks or report lower monetary damage of these events. Additionally, we analyse whether income and consumption of households undertaking risk mitigation measures increase due to these measures and if this increase remains evident in case the household experiences a shock.

The remainder of the paper is structured as follows: the second section takes a closer look at the existing literature on risk mitigation measures and their effects on rural households in developing countries; the third section relates these findings to a conceptual framework of how risk mitigation has an impact on households. Section four describes the data and derives factors that need to be controlled for. Section five presents the methodology, section six results and section seven concludes.

5.2 Literature Review

The literature on risk mitigation and extreme weather is diverse and abundant as weather risk is one of the most prevalent risks in rural households in both Africa and Asia (Thomas et al. 2007, Waibel et al. 2013). To understand how household- or village-level risk mitigation measures could reduce livelihood stress due to adverse weather events, the literature provides knowledge about what shapes household perception of risks, how this perception translates into mitigation measures and what the impact of these measures on the household is.

Generally, household perception of climatic risks is related to its recent experience of weather variability, and experience of extreme weather events relates to belief in long-term climate change (Akerlof et al. 2013, Dai et al. 2015, Demski et al. 2017). Perception is an important factor in taking risk mitigation measures. For example, Waibel et al. (2013) find perception of climate risk and employment of risk mitigation measures being highly related to experience of adverse climatic events in the recent past. Deressa et al. (2009) note that taking up climate change adaptation measures at farm-level is closely connected to farmers‘ recent perceptions of climate variability. Similarly, Bryan et al. (2009) find that measures that are explicitly named as long-term climate adaptation measures are in fact aimed at reducing the impact of extreme weather shocks in response to recent events. However, recent shock experience does not necessarily always translate into high risk perception. Patt and

Schröter (2008) find that after a disastrous flood in the year 2000 villagers from Mozambique were not willing to accept relocation from their flood-prone farms in the plains to new houses in the hillside because they disagreed with the local government about the danger of future floods. Lebel et al. (2016) show that Thai fish farmers' perceptions of climate change are not associated with effects of recent extreme weather events. These differences in personal perceptions and subsequent adaptation choices with regards to weather risk and climate change can at least partially be explained by overestimated small probabilities and recency bias, i.e. the higher weight of recent events in present perception (Weber 2010).

Nevertheless, it becomes clear that climate change adaptation and weather risk mitigation go hand in hand at farm level. Both are essentially triggered by short- and medium-term observations of extreme events and climatic variability that raise household awareness of risk. This means that household- and village-level action for risk mitigation and climate change adaptation cannot be differentiated as separate concepts. Consequently, we consider household-level climate change adaptation measures and mitigation of weather risks as synonyms.

Most evidence on farm-level adaptation and risk mitigation comes from Africa. In response to increased drought risk, farmers adjust their farming practices by changing crop varieties, adopting irrigation, planting trees, investing in soil conservation or adjusting planting dates. Furthermore there is evidence on adjusted income generating activities such as complementary livestock keeping, collective action for irrigation as well as greater off-farm labor supply (Thomas et al. 2007, Bryan et al. 2009, Deressa et al. 2009). Yet, Bryan et al. (2009) also report that 62 % of the farmers they interviewed in South Africa did not adapt to perceived changes in temperatures and rainfall.

The evidence on impacts of risk mitigation measures on farm-level consumption and income is even more limited. Praneetvatakul et al. (2013) find that diversification of crop portfolio leads to a higher future consumption of Vietnamese households and lower chance to be poor. For Thailand they find that the same result is reached by diversifying off-farm labor. Di Falco et al. (2011) find that adaptation strategies such as conserving soil and water, changing crop varieties and planting trees lead to higher agricultural productivity in Ethiopia. Furthermore, farmer's resilience of food productivity to rainy season rainfall increases for adapters while they cannot prove a significant impact for other rain events and varying temperatures in comparison to non-adapters. Di Falco et al. (2012) confirm positive effects of the same adaptation measures in Ethiopia on both farm productivity and net revenues.

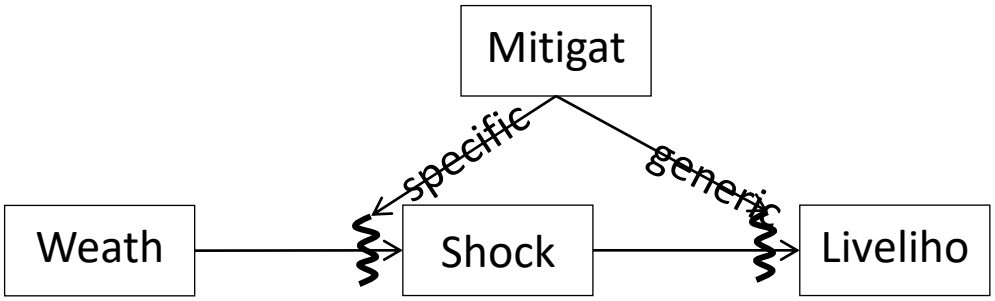
The overall positive effects of climate change adaptation measures on rural households are undoubted since farmers' adaptation behaviour seems to be primarily driven by financial and managerial considerations such as increasing profits and sales (Li et al. 2017). Yet, it remains unclear how they are

effective. Along the generic capacity line of thinking, a positive effect of adaptation measures on consumption would result in higher income, as suggested by Di Falco et al. (2012), even in the absence of extreme events. Higher income and consumption would mean less poverty and hence higher resilience to extreme events. However, mitigation may also be helpful in reducing the number of shocks and the amount of damage done by specific events, consequently resulting in higher income and consumption as found in the studies cited above.

5.3 Conceptual Framework

Our conceptual framework (figure 1) describes how extreme weather events pose risks to household livelihoods and the mechanisms of *ex ante* risk mitigation. In general, households are exposed to weather as a risky factor. When extreme weather events occur, these may cause an economic shock, i.e. damage due to drought, storm or flood. This shock may consequently cause livelihood stress in terms of income loss or consumption reduction. Heitzmann et al. (2002) identify three types of strategies in *ex ante* risk management: a) measures which prevent risky events from occurring, b) actions that prevent or reduce exposure to such events and c) measures that provide compensation in case of losses due to shocks. Since weather is a factor rural households cannot influence, strategies of the first type do not exist in this case. The other two types of strategies, actions reducing exposure and taking measures that provide compensation, go hand in hand with the framework by Eakin et al. (2014) who differentiate specific and generic mitigation measures.

Figure 1: Coneptual Framework.



Source: own illustration based on ideas by Eakin et al. (2014) and Heitzmann et al. (2002).

Specific mitigation measures aim to prevent certain events or lower their damage by reducing household exposure to extreme weather events. Mitigation strategies such as building dikes, establishing an irrigation system or diversifying income sources may reduce the chance to be adversely affected by extreme weather events or the amount of damage by decreasing the dependency of income on weather. If a household applies specific strategies successfully, it should report less shocks or less damage due to shocks. Also, its income and consumption should be less affected in case of shock.

Generic adaptation measures help households compensate and deal with extreme events. This channel is connected to resilience of livelihoods and consumption smoothing. Extreme events can be compensated by using e.g. savings and buffer stocks or taking a loan to compensate losses. This leads to a better livelihood outcome for the household in case of shock. Such a household should report fewer shocks or less severe shocks and its consumption should be less affected.

5.4 Data

5.4.1 Data collection and definition

We use panel data on about 1900 rural households in three provinces (Ha Tinh, Thua Thien Hue, Dak Lak) in Vietnam collected in four waves between 2007 and 2013 under the DFG FOR 756. It is a unique dataset due to its length and as it combines data on all income generating activities a household undertakes with socio-economic data on the household members, information on shocks and risks the household faces, risk attitudes, information about assets and access to credit. Additionally, village-level data is recorded in a separate questionnaire. For a general description of this dataset see Hardeweg et al. (2013). In each survey wave, the questions on shocks and risks refer to a reference period of up to five years so that information is available for all years between 2002 and 2013. The data contain separate information on the three most important kinds of extreme weather events in Vietnam: storms, droughts and floods.

There is information about past shock experience and its damage as well as about risk measured as expected frequency of occurrence in the next five years and expected severity in case of occurrence. The time horizon of the panel enables us to trace the effect of mitigation measures over a period of five years after they were taken in comparison to a five year period before they were taken. The 12-month period from 2007 to 2008 for which risk mitigation was recorded is not considered when measuring shocks, consumption or income. The reason is that risk mitigation is related to risk perception and risk perception is correlated with recent shock experience (Tongruksawattana et al. 2013). If we included the risk mitigation measurement period into our 5-year periods, these would contain information about an increased number of shocks for risk mitigators in the first 5-year period, thereby distorting results.

5.4.2 Shocks and mitigation measures

Table 1 depicts the number of observations for each shock per annum and their respective damage. The low number of observations per annum shows that in relation to the subject, i.e. extreme weather events, five years are a rather short time period to observe. In Ha Tinh and Hue households have a 12% annual chance to be affected by a shock due to extreme weather while it amounts to 18% in Dak Lak. The largest single risk is the drought risk in Dak Lak with about 14% per annum. Here, the average damage due shocks is also highest with about 700 PPP-$. In general, the number of shocks reported and their damage correspond to each other. The shocks reported by households are subjective in their nature: A household will only report a shock if losses occurred or there was livelihood stress. If something happened and the household could deal with it well, the survey will likely not capture this event. This is reflected in the even lower reported number of shocks with a low impact. We expect damage due to shocks to be less subjective and hence anticipate more robust estimation results for this measure.

The people in the sample employ a wide variety of risk mitigation measures. They can be summarized in three groups of adaptation activities (see table A1 in appendix A): investment activities, adjustments in income components, and use of savings, credit and insurance. Investment activities include investment into physical and human capital or in security of the homestead, participation in collective action to build infrastructure in the village, or common property resource management. All these measures may reduce exposure and hence lead to less or less severe shocks for the household. Adjustments in income components include agricultural diversification, income diversification and migration. These measures have a twofold impact: on the one hand they reduce exposure by providing different sources of income which are not equally hit by extreme weather events and on the other hand they provide options to undertake consumption smoothing once a shock hits the household. Measures from the third group, savings, credit and insurance, include keeping buffer stocks and being a member in social organizations. They are purely designed for consumption smoothing. Whereas these measures increase household capital, income and consumption and hence improve its resilience, they are also designed to increase generic adaptive capacity.

Table 2: Number of observed shocks and damage per household per annum.

	Ha Tinh		Dak Lak		Hue	
	Number of shocks p.a.	Damage	Number of shocks p.a.	Damage	Number of shocks p.a.	Damage
All shocks	0.1175	274.42	0.1861	776.15	0.1238	186.44
	(0.181)	(905.351)	(0.163)	(2200.307)	(0.175)	(719.809)
Flood	0.0673	192.56	0.0317	46.43	0.0532	77.17
	(0.118)	(763.303)	(0.083)	(336.0112)	(0.100)	(461.795)
Drought	0.0323	49.28	0.1388	700.68	0.0224	52.31
	(0.080)	(369.524)	(0.134)	(2141.205)	(0.068)	(390.093)
Storm	0.0179	32.58	0.0156	29.03	0.0481	56.95
	(0.062)	(226.286)	(0.056)	(177.150)	(0.100)	(278.781)

Significance levels: **** p<0.005, *** p<0.01, ** p<0.05, * p<0.1
First row: mean values, second row: standard errors

5.4.3 Risk mitigators

Households' decision to undertake a risk mitigation strategy is an ongoing process which is influenced by many factors, both internal and external to the household (Smit and Skinner 2001). Bryan et al. (2009) find that households with recent shock experience undertake mitigation measures more often than households that did not experience a shock. Furthermore, they find that larger household size, access to formal credit and amount of land area increase the chance to undertake mitigation measures. Waibel et al. (2013) show that recent shock experience translates into higher perceived risk for the future. With regards to climate change, Deressa et al. (2009) find that education has a positive influence on taking adaptation measures. Furthermore, Gbetibouo et al. (2010) name off-farm activities as an influence factor for taking adaptation measures. Additionally, there may be peer effects when other households in the village decide to take risk mitigation measures (Angrist 2014).

We define households that report to undertake a risk mitigation measure in 2008 as mitigators, the other households are non-mitigators. Descriptive analysis of our data shows significant differences between mitigators and non-mitigators in a number of variables (compare to table 2) in 2007. For example, risk mitigation measures are more often applied by households facing higher risk but having lower risk aversion. We measure risk exposure as a score, taking the number of times a household expects a shock to happen in the next five years times its expected severity with 1 being no impact and 4 being high impact. Furthermore, we find households undertaking risk mitigation measures to be more often member in a socio-political organization and the value of their tangible assets tends to be lower than of non-mitigating households. Moreover, households from villages with other adapters are more likely to take part in risk mitigation measures. Although there are significant differences in mitigators and non-mitigators with regards to the share of households in their village hit by extreme

weather shocks every year, these differences are not clear-cut across different types of shocks. In some cases mitigators come from villages with higher shares of shocks, in others the share of households in the village hit by shocks is lower. Additionally, we find a smaller household size, higher literacy rates, and better access to credit for mitigators at least for some shock types. Finally, ethnicity seems to play a role in adapting to different shocks, but again the effect is not clear-cut and varies between different types of extreme weather. Some of these factors lead to a situation in which mitigators and non-mitigators may be affected by non-parallel trends, especially with regards to income and consumption. This would violate a major assumption in difference-in-differences models, hence, these differences need to be taken into account when drawing conclusions for the actual effect of mitigation on mitigators.

Table 3: Descriptive statistics and overview of control variables, values are from 2007 only.

	All Shocks			Flood			Drought			Storm		
	adapt =0	adapt =1		adapt =0	adapt =1		adapt =0	adapt =1		adapt =0	adapt =1	
Willingness to take risk	3.184	4.878	***	3.548	4.483	***	3.707	3.056	*	3.286	5.423	***
On 10-point likert scale	0.078	0.131		0.075	0.175		0.071	0.300		0.072	0.172	
Wage employment	0.391	0.422		0.401	0.399		0.399	0.429		0.394	0.429	
Binary, 1 indicates emploment	0.013	0.020		0.012	0.028		0.011	0.052		0.012	0.025	
Business owner	0.773	0.743		0.769	0.735		0.763	0.791		0.768	0.747	
Binary, 1 indicates business	0.061	0.018		0.010	0.026		0.009	0.043		0.010	0.022	
Literacy Household Head	0.858	0.888	*	0.868	0.862		0.867	0.879		0.860	0.899	**
Binary, 1 indicates literacy	0.061	0.013		0.008	0.020		0.008	0.034		0.008	0.015	
Member Socio-Political Org.	0.672	0.771	***	0.689	0.775	***	0.697	0.800	**	0.686	0.769	***
Binary, 1 indicates membership	0.012	0.017		0.011	0.024		0.010	0.480		0.011	0.021	
Household Nucleus Size	4.373	4.354		4.346	4.500		4.360	4.527		4.419	4.140	***
No. of members present more than 183 days/year	0.047	0.066		0.042	0.096		0.039	0.157		0.043	0.083	
Kinh	0.764	0.861	***	0.796	0.772		0.794	0.758	**	0.767	0.907	***
Binary, 1 indicates ethnic majority	0.011	0.014		0.009	0.024		0.009	0.045		0.010	0.015	
Access to Credit	1.712	1.864	***	1.718	1.986	***	1.749	1.933	**	1.743	1.819	
1=good – 6=bad	0.022	0.037		0.020	0.058		0.019	0.108		0.021	0.042	
Tangible assets	19424	1401	***	1872	1242	***	1805	1292	*	1857	1455	***
Value of tangible assets, in 2005 PPP$	70.02	70.37		61.06	80.46		55.86	145.03		62.41	93.63	
Risk score	5.733	8.267	***	2.455	4.247	***	3.717	4.824	**	+	+	
Measure of risk felt by household	0.173	0.304		0.091	0.230		0.097	0.430				
Share adapters in village	0.219	0.472	***	0.111	0.324	***	0.134	0.303	***	0.130	0.194	***
Share of adapters in village	0.006	0.005		0.003	0.008		0.003	0.017		0.004	0.008	
Share of hh with shocks in village per annum	0.106	0.058	***	0.031	0.057	***	0.056	0.022	***	0.002	0.005	***
Avg, measured in past 5 years	0.002	0.002		0.001	0.003		0.002	0.003		0.000	0.001	

Significance levels: **** p<0.005, *** p<0.01, ** p<0.05, * p<0.1

First row: mean values, second row: standard errors;

+ for 2007 there is no risk score for storms, in estimation for storms the variable is hence omitted

5.5 Methodology

We employ a Difference-in-Differences (DiD) estimation to identify the effect of risk mitigation measures on the number of shocks experienced by the household, the damage due to shocks, household income and household consumption. First, we estimate a linear regression model in Ordinary Least Squares (OLS) with standard errors clustered at the household level. It has the following form:

$$\boldsymbol{Y_{it} = \alpha_0 + \alpha_1 t_t + \alpha_2 m_i + \alpha_3 m_i * t_t + \overline{\alpha_4}\overline{X_{it}} + \overline{\alpha_5}\overline{V_{vt}} + e_{it}} \quad (1)$$

Y_{it} is the dependent variable; we use the number of shocks, damage due to shocks, log household income and log household consumption as dependent variables in different regressions. α_0 is the regression constant, α_1 to α_3 are scalar coefficients and $\overline{\alpha_4}$ and $\overline{\alpha_5}$ are vectors containing coefficients relating to vectors of control variables. t_t is a binary variable that is zero for the first period (mid 2002 – mid 2007) and one for the second period (mid 2008 – mid 2013). m_i is a binary variable that is one for households that reported to have undertaken risk mitigation measures between mid 2007 and mid 2008. $\overline{X_{it}}$ is a vector of control variables at the household level and $\overline{V_{vt}}$ a vector of village-level control variables, both referring to 2007 for the first period and 2013 for the second period. Table 2 summarizes the variables. The control variables have the purpose to reduce possible doubts about the parallel trend assumption and to take up variation in the model and hence reduce standard errors. Finally, e_{it} is an error term.

To estimate the treatment effect of adaptation $\hat{\delta}$ in DiD, we calculate a linear combination of the coefficients from (1) as follows

$$\begin{aligned}\boldsymbol{\hat{\delta}} = & \left(\boldsymbol{\hat{Y}_{Mitigator,After} - \hat{Y}_{Non-Mitigator,After}}\right) \\ & - \left(\boldsymbol{\hat{Y}_{Mitigator,Before} - \hat{Y}_{Non-Mitigator,Before}}\right) \\ = & \left[(\boldsymbol{\alpha_0 + \alpha_1 + \alpha_2 + \alpha_3}) - (\boldsymbol{\alpha_0 + \alpha_1})\right] - \left[(\boldsymbol{\alpha_0 + \alpha_2}) - \boldsymbol{\alpha_0}\right]\end{aligned} \quad (2)$$

The central assumption of DiD is that treatment and control groups follow a common trend conditional on the control variables. We cannot think of reasons why this assumption could be hurt in our model as the adapter households are spread across all areas of all three provinces in the sample. Hence, extreme weather events should affect adapters and non-adapters in a similar way, leading to similar numbers of shocks and related damage. Similarly, we see no reason why adapters and non-adapters should have a different trend in their income and consumption over time after considering the control variables. If anything, a non-common trend could be assumed when considering that households select into adapter and non-adapters based on their individual risk. However, this would only lead to an underestimation of effects but not affecting our positive findings. The data we use are structured as a

balanced panel for all analyses relating to the overall dataset and certain types of shocks. In one part of the analysis we only consider households for those periods in which they report a shock. In this case the panel is no longer balanced and there are households which may only appear in the first or second period. When we do analyses regarding only one shock type, we only consider those households as mitigators that report mitigation measures for exactly this type of shock.

5.6 Results

The DiD estimation comparing the number of shocks 5 years prior to the reported risk mitigation measures and 5 years afterwards tests for the effect of risk mitigation on the number of extreme events causing livelihood stress. Table 3 summarizes the results for the number of shocks and their severity as perceived by the household. Surprisingly, we do not find any significant evidence that risk mitigation strategies reduce the total number of shocks households report. If anything, the number of shocks reported by mitigators increases between the two five year periods. This result is most prevalent in the estimations for all shocks, but it is also found in the number of storm shocks with medium severity and other shock types in the robustness checks in the appendix B. Our explanation for this is that the shocks we measure are reported on a strictly subjective basis. There is no objective benchmark as to what is a shock. If households that are more pessimistic about their future are more likely to be mitigators this might explain why they report more shocks than other households. Another explanation could be that households who become mitigators expect more shocks to happen in the future, e.g. because they are particularly pessimistic. A pessimistic opinion could even be correct, e.g. because their land is prone to flooding or especially exposed to tropical cyclones. However, we cannot test for either of these hypotheses.

Table 3 further depicts results with regards to the total amount of damage reported by households due to shocks. Across all shocks together the amount of damage seems to decrease. This result is significant in shocks with high and low severity. Decomposing the types of shocks shows that this result is driven by drought shocks, meaning that mitigation measures are particularly successful in reducing the damage due to drought. This result also holds in the robustness checks reported in the tables in appendix B, where it becomes apparent that the Province of Dak Lak is the main driver of this result. Yet, it does not turn completely insignificant even without the data from Dak Lak. The reduction of damage is especially interesting in the light of the previous finding that mitigators have a tendency to report an increasing number of shocks. It means that despite increasing numbers of shocks, the total damage is decreasing.

Table 4: Results Difference-in-Differences in number of shocks and in damage due to shocks for different shock types.

	All Shocks		Flood		Drought		Storm	
n=3892	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage
All	0.031 ***	-397.794 ***	0.007	82.909	0.007	-385.339 ***	0.009	34.637
	0.010	86.176	0.010	58.533	0.012	94.861	0.006	25.821
High severity	0.013 *	-335.338 ***	-0.007	9.855	0.000	-310.398 ***	-0.002	37.271
	0.008	76.182	0.008	44.168	0.007	89.705	0.005	25.102
Medium severity	0.014 *	-18.008	0.011	67.982	0.006	-43.259	0.009 **	-3.106
	0.007	36.868	0.007	41.305	0.009	26.601	0.004	4.501
Low severity	0.003	-45.115 *	0.002	1.358	0.001	-31.389 **	0.003	0.982
	0.003	22.236	0.003	2.098	0.003	12.392	0.002	4.787

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

Lastly, we investigate the income and consumption of mitigators and non-mitigators in table 4. Our results clearly show an overall increase in incomes in mitigating households. Similarly, consumption increases in mitigating households. This is in line with the literature finding increased productivity and consumption in households that apply mitigation measures (Di Falco et al. 2011, 2012, Praneetvatakul et al. 2013). However, our aim is to show if households benefit from risk mitigation measures when a shock occurs. This is why in line two we restrict the sample to households which report shocks in the respective periods of observation. The results from this analysis show that the increase in consumption found in all households remains significant when considering only those households for those periods in which they reported a shock. In contrast, the income effect largely loses its significance. However, it does not turn negative. This confirms our hypothesis: mitigating households do not solely benefit from increased productivity and income due to mitigation, but they are able to maintain higher consumption in case of shock.

Table 5: Results Difference-in-Differences of log income and log consumption for different shock types.

	All shocks		Flood		Drought		Storm	
	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.
All households	0.399 ***	0.259 ***	0.248 ***	0.298 ***	0.282 *	0.273 ***	0.337 ***	0.165 ***
	0.073	0.036	0.080	0.043	0.160	0.079	0.087	0.041
N	3716	3890	3716	3890	3716	3890	3716	3890
Households with shock	0.360 ***	0.280 ***	0.220	0.273 ***	1.045	0.519 *	0.135	0.432 **
	0.120	0.056	0.149	0.076	0.796	0.287	0.359	0.202
n	1877	1981	820	868	1074	1141	470	494

First row: DiD-Point-Estimates, Second row: Standard Errors, Third row: Number of observations;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

We find only weak evidence for increased specific capacity to adapt to climate change at household level. The limited evidence for the existence of measures reducing household exposure to extreme events relates only to reduced damage due to drought. The increase of income and consumption due to risk mitigation and the positive consumption effect that remains in case of shock lead us to the conclusion that the positive effects of risk mitigation are more connected to generic capacity to adapt to climate change than to specific capacity.

5.7 Conclusion

This paper investigates if households in developing countries are able to improve their situation by taking ex-ante risk management strategies to reduce the risk of being adversely affected by extreme weather events such as droughts, floods and storms. We further ask if these households are better off because they reduce the threat to be affected by specific risks or because they improve their generic capacity to deal with economic shocks. Despite the comparatively low number of observations for treatment and the relatively short period observed in relation to the subject of extreme weather events, our results show mitigation reduces damage due to drought, increases overall income and consumption in the absence of shocks and helps households maintain their consumption in case of shock. We conclude that positive effects of risk mitigation measures are mostly related to human development and improved standard of living thereby increasing household resilience. Only a small part of the improvement is due to better protection from specific risks such as drought.

These results indicate that policy makers can support rural households in coping with increased risk due to climate change by encouraging the employment of mitigation measures at local levels. This could be done by improving information of the rural population about effective measures and removing financial barriers to their adoption (compare to the barriers of adaptation found by Deressa et al. (2009) and Gbetibouo et al. (2010)). As a positive side-effect, adoption of risk mitigation measures may also help households increase their overall income and consumption. Still, our results also stress that taking measures preventing a further increase in the frequency of extreme events has to be of utmost importance. This is because the households in our sample are not able to completely evade livelihood stress due to extreme weather events by employing risk mitigation strategies. Instead, merely the worst impact of these events, i.e. a reduction of consumption, is mitigated. An increase in frequency of extreme weather events as it is expected due to climate change will hence induce a loss of income and damage to assets and it is not clear whether this can always be compensated by other positive effects of risk mitigation measures.

One major shortcoming of our results is that we cannot distinguish the impact of different risk mitigation measures such as crop diversification or taking part in collective action to build

infrastructure. There are two reasons why this is impossible: On the one hand separating the different measures leads to even smaller numbers of observations - too low to show statistically significant effects. On the other hand we only know the most important measure a household undertakes and not all of them. Hence, the exact effect of a certain measure cannot be identified in the sample. Further research should tackle this shortcoming and distinguish different mitigations measures, perhaps by extending the time horizon of the study and asking more specifically about mitigation measures.

Another issue which cannot be addressed by this paper is that of increased severity. The IPCC (2012) states that besides an increase of frequency of extreme weather events, Vietnam has to expect an increase in the severity of such events. While we find that risk mitigation at the local level currently helps households reduce the damage of drought shocks, increases income and consumption in the absence of shocks and helps households mitigate the impact of shocks on their consumption, we do not know whether this will still be the case if events get ever more extreme. Future research could tackle this problem by modelling the development of household livelihoods under risk over time in a prediction model, testing the effects of shocks with different severity, e.g. on household consumption.

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Appendix A

Table A1: Most prevalent risk mitigation measures used in Vietnam by shocktype.

Adapt measures Flood	**n**
Collective action for infrastructure, dikes, terraces, irrigation, etc.	142
Buffer stocks (e.g. storage of food, seeds, money at home)	42
Income source diversification	22
Crop, plot, livestock diversifiaction	22
Migration	16
Common property resource management (of forest, lake, etc.)	11
Other	27
Total	282

Adapt measures Drought	
Collective action for infrastructure, dikes, terraces, irrigation, etc.	57
Investment in physical and human capital	7
Income source diversification	5
Buffer stocks (e.g. storage of food, seeds, money at home)	4
Crop, plot, livestock diversifiaction	3
Other	12
Total	88

Adapt measures Storm	
Crop, plot, livestock diversifiaction	199
Income source diversification	47
Investment in physical and human capital	36
Membership in rotating savings and credit associations	31
Savings accounts in financial institutions	17
Other	35
Total	365

Appendix B

Table B1: Difference Difference-in-Differences in number of shocks and in damage due to shocks without Dak Lak Data.

	All shocks		Flood		Drought		Storm	
n=2531	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage
All	0.032 ***	148.781 **	0.008	57.724	0.004	-15.004	0.010	43.120 *
	0.011	67.055	0.010	60.783	0.012	33.508	0.006	25.835
High severity	0.010	70.874	-0.005	-10.883	-0.011	-49.169 *	0.000	42.316 *
	0.009	58.332	0.008	47.057	0.007	25.014	0.005	25.050
Medium severity	0.018 **	73.311 **	0.010	64.117	0.012	36.586 *	0.008 *	-0.226
	0.008	32.213	0.007	41.751	0.009	21.957	0.005	4.539
Low severity	0.004	2.490	0.001	-0.105	0.002	-2.421 **	0.002	1.030
	0.004	6.873	0.003	2.415	0.003	1.130	0.002	5.055

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

Table B2: Results Difference-in-Differences of log income and log consumption without Dak Lak Data.

	All shocks		Flood		Drought		Storm	
	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.
All households	0.077	0.098 **	-0.037	0.166 ***	-0.010	0.152 **	0.113	0.023
	0.079	0.039	0.083	0.045	0.165	0.077	0.088	0.043
n	2433	2530	2433	2530	2433	2530	2460	2560
Households with shock	0.007	0.041	0.0216	0.188 **	1.273	0.342 **	0.336	0.402 *
	0.149	0.067	0.1704	0.083	0.956	0.160	0.375	0.209
n	998	1044	643	675	319	338	372	387

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

Table B3: Difference-in-Differences in number of shocks and in damage due to shocks without Thua Thien Hue Data.

	All shocks		Flood		Drought		Storm	
n=2667	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage
All	0.022	-476.514 ***	0.005	257.897 **	0.035 **	-321.443 **	0.004	-3.638
	0.014	127.444	0.016	128.934	0.017	150.095	0.007	24.169
High severity	0.005	-409.571 ***	-0.018	67.648	0.021 **	-260.939 *	-0.003	-1.847
	0.010	114.563	0.013	93.044	0.010	144.918	0.004	22.813
Medium severity	0.019 *	-4.477	0.023 **	181.784 *	0.014	-22.502	0.008 *	-6.975
	0.010	54.430	0.011	97.099	0.014	41.313	0.005	6.135
Low severity	-0.003	-64.323 **	-0.003	-1.134	0.000	-37.619 **	0.000	6.124
	0.004	29.835	0.004	0.698	0.004	17.739	0.002	6.236

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

Table B4 : Results Difference-in-Differences of log income and log consumption without Thua Thien Hue Data.

	All shocks		Flood		Drought		Storm°	
	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.
All households	0.462 ***	0.253 ***	0.409 ***	0.216 ***	0.275	0.078	0.438 ***	0.292 ***
	0.103	0.042	0.135	0.056	0.193	0.083	0.124	0.047
n	2512	2649	2512	2649	2512	2649	2528	2666
Households with shock	0.546 ***	0.304 ***	0.379	0.201 ***	0.758	0.164		
	0.201	0.070	0.267	0.090	1.108	0.266		
n	1354	1440	522	558	945	1006		

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1;
°No observations for storm shocks in the base period for Thua Thien Hue

Table B5: Difference-in-Differences in number of shocks and in damage due to shocks without Ha Tinh Data.

	All shocks		Flood		Drought		Storm	
n=2642	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage
All	0.037 ***	-719.214 ***	0.005	-13.692	-0.028 **	-646.395 ***	0.015	61.779
	0.014	116.474	0.012	37.144	0.012	197.193	0.011	51.487
High severity	0.024 **	-546.098 ***	-0.005	-11.815	-0.015 *	-457.731 **	0.000	72.837
	0.012	101.982	0.010	34.445	0.009	190.609	0.009	50.672
Medium severity	0.006	-92.218 **	0.005	-4.892	-0.013	-135.944 ***	0.008	-5.494
	0.009	45.364	0.008	15.830	0.009	24.288	0.007	6.714
Low severity	0.009 *	-79.138 **	0.005	3.766	-0.001	-52.302 **	0.007 *	-4.672
	0.005	39.830	0.003	3.490	0.006	21.762	0.004	6.501

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

Table B6 : Results Difference-in-Differences of log income and log consumption without Ha Tinh Data.

	All shocks		Flood		Drought		Storm	
	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.
All households	0.275 ***	0.197	0.180 **	0.366 ***	0.192	0.464 ***	0.275 ***	0.006
	0.094	0.053	0.090	0.060	0.251	0.137	0.104	0.066
n	2487	2601	2487	2601	2487	2601	2524	2640
Households with shock	0.270 **	0.219 ***	0.104	0.399 ***	1.277	0.196	0.415	0.411 *
	0.147	0.079	0.196	0.118	1.086	0.395	0.416	0.210
n	1402	1478	475	503	884	938	362	382

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

Appendix C

Table C1: Number Difference-in-Differences in number of shocks and in damage due to shocks without controls.

	All shocks		Flood		Drought		Storm	
n=4020	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage	Number shocks	Damage
All	0.079 ***	-355.539 ***	0.008	86.778	0.016	-384.295 ***	0.025 ***	50.892 **
	0.011	80.654	0.010	58.185	0.012	84.423	0.007	24.262
High severity	0.047 ***	-301.808 ***	-0.007	13.628	0.008	-310.471 ***	0.008	48.105 **
	0.009	71.658	0.0082	43.716	0.007	80.506	0.005	23.661
Medium severity	0.026 ***	-24.075	0.012 *	66.260 *	0.008	-42.666 *	0.014 ***	0.084
	0.007	33.952	0.007	39.614	0.009	25.231	0.004	4.400
Low severity	0.006 *	-30.312 *	0.002	3.143	0.000	-30.995 *	0.004 *	3.188
	0.003	17.180	0.003	2.983	0.003	12.095	0.002	4.241

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

Table C2: Results Difference-in-Differences of log income and log consumption without controls.

	All shocks		Flood		Drought		Storm	
	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.	Log Income	Log Consump.
All households	0.354 ***	0.235 ***	0.268 ***	0.301 ***	0.375 **	0.270 ***	0.311535 ***	0.1437 ***
	0.070	0.036	0.082	0.045	0.158	0.085	0.087428	0.043
n	3836	4012	3836	4012	3788	3961	3788	3961
Households with shock	0.497 ***	0.290 ***	0.228	0.325 ***	1.086	0.351	0.237	0.367 *
	0.122	0.058	0.175	0.089	1.035	0.332	0.453	0.210
n	1921	2024	829	879	1102	1166	474	499

First row: DiD-Point-Estimates, Second row: Standard Errors;
Significance levels: *** p<0.01 , ** p<0.05, * p<0.1

6 Are Smartphones Smart for Economic Development?

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