Effects of the 2010 Droughts and Floods on Community Welfare in Rural Thailand: Differential Effects of Village Educational Attainment

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Introduction

That the frequency and severity of extreme weather events and natural disasters has increased in the past decades is evident worldwide. Although some anticipated impacts of climate change are positive in certain areas, developing countries are mostly likely to suffer from its negative impacts (IPCC 2001) The climate change models in Southeast Asia projected that the region would experience prominent increases in the intensity and/or frequency of extreme events such as tropical cyclones, droughts, floods, as well as incidence of extreme high sea level (ADB 2009). Apart from fatalities and casualties, these extreme climate events disrupt livelihoods and income generating economic activities. With crops and livestock being destroyed, incomes and consumption decline and savings deplete. This can have long-term implications for wellbeing, future human capital accumulation and economic development.

The impacts of natural disasters both in terms of human and financial losses are distributed disproportionately across social groups so as coping abilities. Social factors such as race and ethnicity, health, education, infrastructure and poverty are considered to be a crucial determinant of vulnerability since they are related to resource distribution, from social to financial assets. Social differentiation in the availability and access to resources makes certain groups more exposed to risk and less capable to adapt.

Consequently, households and communities respond to multiple stressors including climate stress depending on available resources. For instance, while households above poverty line respond to disaster shocks through consumptions smoothing (e.g. selling assets), poorer households are more likely to asset smooth (e.g. decreasing consumption), a strategy which can result in human capital depletion (Hoddinott 2006). On the other hand, households with higher education are found to have lower vulnerability to poverty (Silbert 2011).

The plausible positive effect of education in risk reduction is noteworthy and can have important policy implication. Education is a human capital asset that can increase adaptive capacity, that is “the ability to employ those resources, that are prerequisites to adaptation” (Nelson, Adger and Brown 2007). Education is one important way individuals acquired knowledge, skills and competence that could directly or indirectly influence their coping capacities in time of crisis. More educated individuals may have improved access to and higher ability to interpret and evaluate information (Jerit, Jason and Toby 2006) including information related to climate risks or self-protection. Education endows individuals with real skills that are useful for work and for life such as decision-making ability and problem-solving skills which can be useful in hard times. Likewise, education also indirectly affects adaptive capacity through incomes. Education provide individuals with greater access to full-time, high status, and well

paid work. Thus, education can provide individuals with additional resources (skills, information and relevant knowledge) which may compensate for the assets lost and damages due to climatic shocks.

This paper aims to assess the impacts of natural disasters on community welfare and investigate the role of education as a buffer to livelihood and climate shocks using Thailand as a case study. Given strong reliance on agriculture and natural resources of its economies and annual experience of natural disasters particularly floods, droughts and tropical storms, this paper analyses economic vulnerability to climate events i.e. droughts and floods using village-level survey data from Thailand. We hypothesize that while external climate shocks exacerbate economic vulnerability, the areas with educated population would experience less economic impacts. Education is human capital fundamental to development and unlike physical capital, human capital is transferable and remunerable in different locations. Thus, when experiencing external shocks, areas with high human capital might be able to adapt faster to a new situation and recover faster.

Most extant studies on shocks and vulnerability rely on household surveys which generally comprise a sample of households in a selected area or country. While such data are useful in understanding individual- or household-level vulnerability, they might not be representative at the national level. Exploiting the government survey of all villages located in rural area in Thailand, we are able to explore regional disparities and assess economic vulnerability to external shocks of the whole nation. Besides, whereas studies focusing on impacts of natural disasters in African and Latin American countries are relatively abundant, there is relatively little evidence for countries in Southeast Asia despite the increasing multiple climate threats in the region. This paper thus further provides new empirical evidence for Thailand.

Background of Thailand

Located in the centre of the South-East Asian peninsula, Thailand covers an area of 513,115 km^2 and comprises 76 provinces. The country has 65.5 million inhabitants, the majority of whom (56 percent) live in non-municipal (rural) areas (NSO 2011). Based on economic, social and ecological characteristics, Thailand is usually classified into four geographical regions: Central (including Bangkok Metropolitan Region), North, North East and south. The Central plain is a wide flat fertile land, covered predominantly by the Chao Phraya river valley, which runs into the Gulf of Thailand. This is the most populous and productive region, often referred as the “Rice Bowl of Asia”. The northern part is mainly mountainous and was traditionally covered by dense forest. The Northeast comprises of the semi-arid Khaorat plateau and a few low hills and shallow lakes. Its poor soil and long dry season make the region the least agriculturally productive and the poorest in the country. The South is a narrow peninsula joining the landmass with the Malay Peninsula. It has the highest rainfall in the country.

Thailand is the world’s largest exporter of rice. 12.3 per cent of GDP mainly consists of the output from rice, cassava (tapioca), rubber, corn, sugarcane, coconuts and soybeans. The agricultural sector remains an important economic activity accounting for 12 per cent of the country’s GDP in and 42 percent of total employment in 2009 (World Bank 2012). The industrial/manufacturing sector output accounting for 44 percent of GDP mainly includes food products and beverages, machinery and equipment, textiles

and vehicles. The services sector consists of 43.7 per cent of GDP of which tourism, which particularly developed along Thailand's 3,200 kilometers coastline accounts for 6 percent of GDP.

Thailand's economic activities rely heavily on land and water resources, which are vital to both the development of agriculture and non-agriculture sectors. Apart from the problem of land quality deterioration and problematic soils, many areas have been classified as drought- or flood-prone areas. Highly intensive land use, rainfall fluctuations and physical characteristics in different regions partly contribute to this climate risk (ONREP 2011). The increasing demand for water due to population growth and economic development overstretch water supply. The increasing frequency and severity of droughts and floods further amplifies the water resource tensions.

Although floods are common during the monsoon season and droughts in summer, climate variability in the past decade results in fluctuating rainfalls which increase the risk of severe droughts and floods. In 2005 and 2008, over 11 million people were affected by water shortages which largely damage the rural agricultural region. Meanwhile, in 1994-1995, in 2010 and recently in 2011, an intense rainfall has resulted in the worst floods in half a century. The 2011 flood affected 13.6 million people, 65 provinces and over 20,000 km^2 of farmland. The estimated economic damages and losses equals to US$45.7 billion (World Bank 2012). The impacts of these natural disasters pose significant risks and burden to the development and the environment of the country and can seriously harm the local economy.

Additionally, climate change poses a severe threat to economic activities and livelihoods. Observational records and climate projections predicted that rainfall would increase by about 10-20% across all the regions in Thailand. Mean annual temperature across the country is predicted to increase with the longer period of summer and more days of temperature higher than 33C (Chinvanno et al. 2009). Changes in rainfall patterns and the frequency and intensity of rainfall results in higher frequency of severe floods and droughts. This can cause substantial damage not only to property and human life but also to the ecosystem, agriculture and other economic activities such as food processing and tourism industries which rely heavily on agricultural and natural resources input.

The 2010 droughts and floods

The year 2010 provides evidence of increasing extreme weather events in Thailand. In 2010, Thailand experienced the worst droughts and floods (second to the 2011 floods) in the past two decades. As the tropical rainy season ended earlier than usual in November 2009, together with global warming and El Niño phenomenon, Thailand experienced unusually hot weather and lack of rainfall at the beginning of 2010. As the country enters the hot season in March, experts had issued national drought warnings while the droughts stretched until almost the end of August. The Disaster Prevention and Mitigation Department declared 64 provinces as disaster areas due to severe water shortages. Nearly 16 million people had been adversely impacted by drought which mainly damaged agricultural production. The drought caused damage to 1,716,453 rai of farmland with the estimated loss of 1.5 billion baht.

Later in the year, Thailand experienced a series of flash floods and inundation for seven times. From 15 July-30 December 2010, all regions in Thailand were hit by floods due to La Niña phenomenon which brought about higher than average rainfall and longer period of precipitation. The southern part was

further hit by a tropical depression which brought about heavy rainfall and flash floods lasting from 1 November 2010 – 25 February 2011. The death toll from the floods stands at 266 people with 1,665 people injured. In total 74 provinces were affected by the floods, 10,909,561 rai of farmland was damaged with the total estimated loss of 16 billion baht. A long severe drought prolonging beyond the first half of the year, followed by a destructive flood later in the year made 2010 a year to represent the impacts of climate variability.

Measurement of community welfare

In this study, community welfare is measured by income and consumption, which are common direct observable measures of welfare level after experiencing external climatic shocks (Skoufias and Vinha 2012). Both droughts and floods can damage crop production via a decrease in cultivated area and crop yield which leads to income loss. In addition, floods can destroy households, assets and infrastructure which can inhibit income generating activities. Facing income variability and livelihood disruption, rural households in developing countries adopt various strategies to cope with climate risk. Reducing expenditures on food and non-food consumption is one way to deal with reduction in household income .

Households may also change investment priorities due to limited economic resources. For example, to supplement income, households may send their children to work instead of school thus reducing investment in human capital (Jacoby and Skoufias 1997). On the other hand, upon seeing that natural disasters can reduce the expected return to physical capital, rational individuals may shift their investment towards human capital instead (Skidmore and Toya 2002). Since there is evidence that household adjust their consumption in response to an adverse shock differentially e.g. reducing non-food consumption but not food consumption, it is important to analyse the impacts of catastrophic climate shocks on different dimensions of welfare. This study use five items as an indicator of welfare, namely, food expenditure, non-food expenditure, productive expenditure on agriculture, expenditure on education and income.

Data

Data from difference sources are used to analyse the impacts of natural disasters on village welfare. Information on demographic and socio-economic characteristics at the district-level is obtained from two data sources: Basic Minimum Need Survey (BMN) and the National Rural Development Committee Survey (NRD 2C). Administered by the Community Development Department (CDD), Ministry of Interior, both surveys cover all villages in 76 provinces in Thailand where 1) there are all areas in rural area (non-municipal area); and 2) where there are areas both in rural area and non-municipal area (excluding the village where there are all areas in Pattaya municipal areas and Bangkok Metropolitan). This covers approximately 70,000 villages accounting for about a half of the Thai population.

The BMN is annual survey of every household from villages and communities all over Thailand. The survey objective is to improve the quality of life of household members through enabling local people and communities to meet their own basic minimum needs in 5 dimensions: health, dwelling, education, economy and values. The survey is a face-to-face interview of a head or members of a household by

interviewers selected from the members of that village using a structured questionnaire. The data are then processed and aggregated at the subdistrict, district, provincial and national levels.

The NRD 2C is a bi-annual survey of living conditions in a village focusing on 6 themes: infrastructure, employment/agricultural productivity and income, health and sanitation, knowledge and education, community strength and natural resources and environment. The structured questionnaire is filled out by members of the village committee, the village head and local government officials. The latter provide information related to their work e.g. village health statistics, death registration and education of people in a village.

The two surveys provide extensive information on local area demographic, physical, economic and social conditions covering every villages in the country accounting for approximately 60% of Thai population. Since the BMN and the NRD 2C are collected annually and bi-annually, this allows us to construct a panel data and assess economic vulnerability after the natural disaster events accounting for village characteristics in the year before the disasters occurred.

The analysis sample is for the years 2009 and 2011 comprising 68,695 villages with non-missing information for the two years period. We match this sample with district-level disaster data i.e. the floods and droughts report for the year 2010, complied by the Department of Disaster Prevention and Mitigation, Ministry of Interior. The flood and drought reports contain information on the number of population, households and villages affected by flood/drought, estimated economic loss and the amount of public aids.

Methods

The analysis is an ex-post assessment of the extent to which climate shocks cause economic vulnerability at the village level. In this study, vulnerability is defined as a function of shocks, susceptibility and resilience and namely the interplay between the realization of stochastic events (i.e. shocks) and individual's, household's, community's, country's ability to anticipate and respond to such events. A community is considered vulnerable to floods and droughts if the risk will result in a loss of wellbeing or welfare where the individual or household in a community is unable to cope.

Areas affected by droughts and floods in 2010 might experience lower crop yields which in turn lead to income reduction. Consequently, villagers might opt to reduce consumption to cope with income loss. Certain coping strategies such as cutting down expenses on education could further exacerbate economic vulnerability since it inhibits human capital investment. We use a difference-in-difference approach to assess the effects of floods and droughts on community welfare level following a commonly used equation to estimate the degree of consumption smoothing (Townsend 1994, 1995).

The model estimating community welfare can be defined as:

$$\Delta \ln w_{it} = \gamma Sc_{jt} + \beta Si_{it} + \delta X_{it} + \partial E_{it} + \Delta \varepsilon_{at}$$

where

$\ln w_{it}$ is first difference in the logarithm of expenditures on food, non-food, agriculture and education and income of village *i* between years 2009 and 2011;

Sc_{jt} is a stochastic measures of floods and droughts in district *j* in 2010;

Si_{it} represents a series of demographic structure and socio-economic characteristics of village *i* (proportion of people aged 0-14; proportion of people aged 60+; proportion of people with disability; proportion of female headed household; proportion of sick people; proportion of deaths; proportion of agriculture area; proportion of households engaging in agriculture; proportion of households with insufficient access to water; and proportion of household without electricity access);

X_{it} is a vector of self-report of environmental and economic constraints in land use for agriculture (poor soil quality; labour shortage; crops plantation not breaking even with investments; lack of knowledge to grow other crops; shortage of water; inundations) ; and

E_{it} is a vector of education composition in village *i* (proportion of people with lower secondary education; proportion of people with at least upper secondary education).

Note that in the models estimating expenditures, we use weather shocks and changes in self-report of environmental and economic constraints in land use for agriculture as proxies for income following the previous study (Skoufias and Vinha 2012).

Measurement of floods and droughts

The exposure to floods and droughts are measured at the district level. Although the village might not be hit directly by floods/droughts, there could be indirect effects of the natural disasters which are common to all villages within a district such as food shortages, rising food prices, ruptures in infrastructure or transportation. Using the information on the number of villages affected by floods and droughts in the district, the scale of floods/droughts is divided into 5 levels:

0 = No villages were hit by floods/droughts;
1 = 1 - 24% of villages in the district were hit by floods/droughts;
2 = 25 - 49% of villages in the district were hit by floods/droughts;
3 = 50 - 74% of villages in the district were hit by floods/droughts;
4 = 75 - 100% of villages in the district were hit by floods/droughts

Table 1 shows the distribution of the proportion of villages affected by floods and droughts in the district. Both droughts and floods were widespread in rural Thailand in 2010. More than half of the villages are located in the district where all villages were affected by droughts and floods. Only 7% and 19% of villages are located in the district where none of the villages were hit by floods and droughts respectively. The variation in flood and drought exposure could pose different effects on welfare of villagers.

Table 1: Distribution of village exposure to floods and droughts

	Not exposed	1-74% of villages exposed	All villages exposed	N
Drought	0.20	0.30	0.50	68,695
Flood	0.07	0.41	0.52	68,695

Empirical results

Welfare effects of droughts and floods

Matching the floods and droughts data with the village survey data, we then run a series of difference-in-difference OLS regressions assessing the short impacts of floods and droughts exposures on welfare – expenditures and income – as well as exploring the determinants of such economic vulnerability. Table 2 presents regression results of the estimates of expenditures on food, non-food, agricultural inputs and education as well as income.

The village socio-demographic characteristics associated with income are in the expected direction. The greater the proportion of children (those aged 0 – 14 years), the elderly (those aged 60 years and over), people with disability and female headed households in the village, the lower the village income is. Economic shock due to the increase in the number of deaths has negative impact on Income. Access to water and electricity can be a proxy for the level of development of a village and the lack of access to such facilities is negatively associated with income. The increase in the proportion of households engaging in agriculture results in income reduction. Income also decreases with the increase in the problems with poor soil quality and water shortage. As for the impacts of droughts and floods, we find that income marginally increases with one unit increase in the scale of floods by 0.01% and decreases with one unit increases in the scale of droughts by -0.01%.

Education is positively related with income. One per cent increase in the proportion of villagers with lower secondary education and upper secondary education and higher results in an income increase by 43% and 65% respectively.

The coefficient estimates of log floods and droughts show that an average village consumption per month is protected against any negative income shocks from floods and droughts. We find no evidence that expenditures on food and non-food declined the greater the villages are exposed to droughts and floods. On the opposite, we find significant positive impact of floods and droughts in all expenditures. This suggests that communities are able to keep their consumption from deteriorating as found in previous studies on developing countries that household consumption are rather smooth when hit by economic shocks (Islam and Maitra 2012).

Table 2: Difference-in-difference estimates of economic outcomes: main models

	Food expense	Non-food expense	Agricul-ture expense	Education expense	Income
P lower secondary	0.970	1.520	2.383	2.797	0.428
	(2.83)**	(4.80)**	(4.91)**	(7.25)**	(9.41)**
P upper secondary & higher	0.117	0.944	-1.447	2.063	0.653
	(0.34)	(3.00)**	(3.00)**	(5.38)**	(14.46)**
P female headed household	0.092	0.015	0.129	-0.184	-0.081
	(0.60)	(0.11)	(0.59)	(1.06)	(3.95)**
P aged 0 – 14	3.252	2.854	8.165	7.209	-0.599
	(5.22)**	(4.95)**	(9.24)**	(10.27)**	(7.23)**
P aged 60 and over	1.212	0.480	4.775	1.400	-0.883
	(2.90)**	(1.24)	(8.04)**	(2.97)**	(15.86)**
P disabled	-1.349	-0.622	-0.569	-1.158	-0.856
	(2.40)*	(1.20)	(0.71)	(1.83)	(11.54)**
P sick people	0.115	0.071	-0.177	0.074	0.059
	(1.15)	(0.77)	(1.25)	(0.66)	(4.47)**
P of deaths	-0.084	0.161	1.900	0.726	-1.109
	(0.07)	(0.14)	(1.05)	(0.51)	(6.61)**
P agricultural area	0.001	0.000	0.002	0.001	0.000
	(0.50)	(0.23)	(0.88)	(0.84)	(1.17)
P households in agriculture	-0.018	-0.027	0.053	-0.135	-0.063
	(0.94)	(1.51)	(1.95)	(6.26)**	(24.80)**
P household with insufficient water	0.071	-0.017	0.220	0.099	-0.020
	(1.29)	(0.34)	(2.83)**	(1.60)	(2.78)**
P household with no electricity	0.325	0.251	0.797	0.268	-0.110
	(1.07)	(0.89)	(1.85)	(0.78)	(2.72)**
Problem with poor soil	-0.017	0.024	0.144	0.047	-0.022
	(0.35)	(0.51)	(2.03)*	(0.84)	(3.31)**
Problem with labour shortage	0.140	0.118	0.106	0.112	0.010
	(2.31)*	(2.09)*	(1.23)	(1.64)	(1.30)
Problem with crop planted	0.031	0.006	0.172	0.070	-0.006
	(0.61)	(0.12)	(2.38)*	(1.21)	(0.91)
Problem with lack of knowledge	-0.042	-0.085	-0.017	-0.025	-0.012
	(0.77)	(1.68)	(0.21)	(0.41)	(1.69)
Problem with water shortage	0.082	0.135	0.363	0.101	-0.021
	(1.84)	(3.27)**	(5.73)**	(2.01)*	(3.60)**
Problem with inundation	0.032	0.021	0.027	0.010	0.006
	(0.56)	(0.41)	(0.33)	(0.16)	(0.80)
Log flood index	0.034	0.021	0.087	0.037	0.007
	(4.62)**	(3.00)**	(8.32)**	(4.43)**	(6.93)**
Log drought index	0.041	0.030	0.179	0.060	-0.011
	(8.89)**	(6.99)**	(27.47)**	(11.69)**	(18.34)**
Constant	0.088	0.072	0.278	0.205	0.026
	(2.79)**	(2.46)*	(6.24)**	(5.79)**	(6.14)**
Observations	66634	66627	66621	66635	66635
R-squared	0.00	0.00	0.03	0.01	0.04

Absolute value of t-statistics in parentheses
* significant at 5% level; ** significant at 1% level

Table 3: Difference-in-difference estimates of economic outcomes: interaction models between education and climate shocks

	Food expense	Non-food expense	Agricul-ture expense	Education expense	Income
P lower secondary	0.915	1.489	2.249	2.780	0.428
	(2.66)**	(4.68)**	(4.62)**	(7.18)**	(9.40)**
P upper secondary & higher	0.311	1.089	-0.944	2.282	0.627
	(0.91)	(3.44)**	(1.95)	(5.93)**	(13.83)**
P female headed household	0.067	0.014	0.105	-0.143	-0.077
	(0.43)	(0.10)	(0.48)	(0.82)	(3.71)**
P aged 0-14	3.112	2.755	7.812	7.061	-0.575
	(4.99)**	(4.77)**	(8.85)**	(10.05)**	(6.93)**
P aged 60 and over	1.164	0.450	4.588	1.369	-0.881
	(2.77)**	(1.16)	(7.74)**	(2.90)**	(15.82)**
P disabled	-1.307	-0.586	-0.446	-1.221	-0.829
	(2.31)*	(1.12)	(0.56)	(1.92)	(11.09)**
P sick individuals	0.128	0.077	-0.179	0.070	0.058
	(1.28)	(0.83)	(1.26)	(0.62)	(4.41)**
P of deaths	-0.019	0.220	1.976	0.809	-1.112
	(0.01)	(0.19)	(1.10)	(0.57)	(6.64)**
P agricultural area	0.001	0.000	0.002	0.001	0.000
	(0.49)	(0.19)	(1.04)	(0.68)	(1.30)
P households in agriculture	-0.023	-0.028	0.049	-0.136	-0.062
	(1.18)	(1.59)	(1.78)	(6.25)**	(24.08)**
P household with insufficient water	0.071	-0.017	0.213	0.099	-0.020
	(1.30)	(0.34)	(2.74)**	(1.60)	(2.69)**
P household with no electricity	0.318	0.248	0.730	0.259	-0.105
	(1.05)	(0.88)	(1.70)	(0.76)	(2.60)**
Problem with poor soil	-0.026	0.019	0.121	0.034	-0.022
	(0.52)	(0.40)	(1.71)	(0.61)	(3.23)**
Problem with labour shortage	0.141	0.118	0.115	0.108	0.010
	(2.31)*	(2.10)*	(1.33)	(1.58)	(1.24)
Problem with crop planted	0.027	0.003	0.164	0.068	-0.007
	(0.53)	(0.07)	(2.27)*	(1.17)	(0.98)
Problem with lack of knowledge	-0.039	-0.082	-0.017	-0.021	-0.012
	(0.72)	(1.62)	(0.22)	(0.34)	(1.63)
Problem with water shortage	0.075	0.129	0.352	0.096	-0.021
	(1.68)	(3.12)**	(5.55)**	(1.91)	(3.54)**
Problem with inundation	0.021	0.011	0.004	0.002	0.006
	(0.37)	(0.22)	(0.05)	(0.04)	(0.78)
Log flood index	0.125	0.131	0.250	0.322	-0.050
	(0.83)	(0.94)	(1.17)	(1.90)	(2.54)*
Log drought index	-0.215	-0.276	0.845	-0.188	-0.073
	(2.38)*	(3.30)**	(6.60)**	(1.85)	(6.07)**
Log flood index*	-0.100	-0.138	-0.222	-0.330	0.063
P lower secondary	(0.64)	(0.95)	(0.99)	(1.85)	(3.02)**
Log flood index*	-0.081	-0.043	-0.008	-0.194	0.048
P upper secondary	(0.52)	(0.30)	(0.04)	(1.11)	(2.35)*
Log drought index*	0.178	0.256	-0.934	0.176	0.076
P lower secondary	(1.84)	(2.87)**	(6.86)**	(1.63)	(5.91)**
Log drought index*	0.508	0.488	-0.043	0.482	0.034
P upper secondary	(5.58)**	(5.79)**	(0.34)	(4.70)**	(2.84)**
Constant	0.103	0.079	0.315	0.212	0.024
	(3.28)**	(2.72)**	(7.07)**	(5.98)**	(5.62)**

Observations	66395	66388	66382	66396	66396
R-squared	0.01	0.00	0.04	0.01	0.04

Absolute value of t-statistics in parentheses
* significant at 5% level; ** significant at 1% level

In terms of physical capital and human capital investment, we do not find that communities cut down their expenditures on agriculture nor education. Agricultural expenditures are cost of production including spending on seed/animal breeding cost, chemical cost (e.g. fertilizer) and other costs (e.g. machinery, petrol). When facing with problems on land use such as poor soil quality or water shortage, expenditures on agriculture increase. Similarly, agriculture spending also increased for villages located in the district with greater exposure to floods and droughts. This shows that communities do not shy away from investment in agricultural production due to expected lower returns to investment or high risks involved.

Similar to the previous study on the effects of natural disasters on educational investment in Indonesia (Kim and Prskawetz 2010), we find that spending on education increases with the scale of floods and droughts. In particular, education expenditures increased, the higher the average level of education in the villages is. Spending on education nevertheless declined the greater the proportion of households engaging in agriculture is in the village while the opposite is true for spending on agriculture. This shows that for communities whose main economic activity is agriculture, investment in education is lower.

Differences in welfare effects by community educational attainment

In order to explore heterogeneity in the impacts of natural disasters on consumption and income by level of education, we interact the variables on village educational attainment with exposure to floods and droughts. Table 3 displays the effects of floods and droughts on community welfare given different distribution in educational attainment in the villages.

The interaction terms between average level of education in the villages (i.e. proportion of people with lower secondary education and proportion of people with upper secondary education and higher) and climate shocks show the educational variation in flood and drought impacts on consumption and income. For consumption, we find that expenditures on food and non-food decreased with exposure to droughts. However, villages with higher proportion of those with secondary education especially upper secondary education and higher do not experience such a decline. Consumption of communities with lower level of education thus are more vulnerable to droughts than those with the average higher level of education. Similarly, for educational expenditure, villages with higher level of education on the average are far more likely to be able to increase the level of spending on education even with drought exposure.

With respect to income, we find distinctive educational variation in income changes after the climate shocks. Villages with higher level of education clearly experience an increase in income with exposure to floods and droughts while the villages with lower proportion of members with secondary education and higher experienced significant income reduction after the floods and droughts. This suggests that higher

education may offer more varieties of coping strategies such as borrowing, receiving help or alternative income sources.

Concluding remarks

In this paper, we investigate how Thailand's worst droughts and second worst floods in two decades affect community welfares. Our results suggest that rural communities are able to smooth consumption such that droughts and floods do not produce a negative effect on food and non-food expenditures. Rather than cutting down their investment in physical capital and human capital in order to smooth consumption on necessary items such as food, we find that spending on agriculture and education increased with flood and drought exposure. The increase in all expenditures is reflected by income estimation. We do not find evidence that income declines following droughts and floods experience.

We further observe that there is significant variation in consumption smoothing by community's educational attainment level. While communities with lower level of education are prone to lower food and non-food consumption as well as lower spending on educational investment after climate shocks, communities with higher proportion of members with at least secondary education enjoy the increase in income and consequently consumption.

This finding shed light on positive externalities of education. In normal time education enhances skills and knowledge which in turn can increase earning capacity. This paper shows that education could also reduce vulnerability by enabling individuals, households and communities to overcome hardship in difficult time such as after natural disasters.

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