

DO NATURAL DISASTERS CHANGE SAVINGS AND EMPLOYMENT CHOICES? EVIDENCE FROM BANGLADESH AND PAKISTAN

Shaikh M.S.U. Eskander, Samuel Fankhauser, and Shikha Jha

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ABSTRACT

We investigate the economic response of households to natural disasters in Bangladesh and Pakistan. In particular, we explore to what extent households adjust their income and employment strategies and savings in response to exposure to floods and storms. Using two unique panel datasets, we find evidence of autonomous adjustments in both countries. In Bangladesh, farmers move away from farm to nonfarm employment as a coping strategy to tackle immediate reductions in their total household income from exposure to disasters, whereas nonfarmers increase their off-farm labor supply. Such adjustments in employment strategies are stronger among the storm-affected households than the flood-affected households. On the other hand, although farmers in Pakistan move away from agriculture as an immediate response to disasters, they eventually come back to agriculture within a year of disaster exposure. We also identify that such adjustments in employment and income strategies help farmers to overcome the immediate losses from disaster exposure as the disaster-affected households from both Bangladesh and Pakistan exhibit at least no decrease in their savings behavior. We discuss policy implications in terms of developing nonfarm employment opportunities to reduce the future harms of disaster and financing economic migration to reduce income vulnerability.

Keywords: Bangladesh, income, natural disasters, Pakistan, savings

JEL codes: D13, D64, Q15, Q24, Q54

I. INTRODUCTION

Natural disasters such as floods and storms particularly harm the rural poor, who mostly depend on agriculture for employment and income. As the rural nonfarm sector is usually tied to agricultural production, rural nonfarm employment and income are also vulnerable to exposure to such climatic events. Climate-induced natural disasters have both short- and long-term harmful impacts on affected households (Maccini and Yang 2009), who may lose their livelihoods, life savings, and creditworthiness. By destroying productive assets acquired through years of foregone consumption, natural disasters can push the poor into deep poverty, making it hard to recover their predisaster consumption levels and rebuild assets (Barnett and Mahul 2007). For example, analyzing 25 years of data from the Philippines, Anttila-Hughes and Hsiang (2013) observed that typhoons destroyed durable assets and depressed incomes, and led in turn to broad reductions in household expenditures. Motivated by immediate survival as well as profit maximization, disaster-affected households may change their employment and income strategies, which may result in changes in their dependence on agriculture. Although the existing literature addresses the welfare effects of increases in agricultural and nonagricultural labor supply (e.g., Mueller and Quisumbing 2011), the possibility of change in dependence on agriculture in the aftermath of a disaster is not yet addressed. Against this backdrop, this paper contributes by investigating the extent of household-level adjustment in income and employment strategies and savings behavior in response to exposure to floods and storms for the case of Bangladesh and Pakistan.

It may be argued that if disaster shocks are anticipated, households would adapt to them. In fact, households who are aware of the potential impacts of common weather shocks try to sustain consumption by adopting low-risk, low-return investment strategies and mitigation measures such as levies to prevent flooding, supplementary irrigation to offset lack of rainfall, and seasonal migration to avoid chronic poverty (Barnett and Mahul 2007). However, when such shocks cannot be anticipated, they may cause a lot of damage. While farmers usually show considerable experience of coping and risk management strategies by taking into account seasonal risks and uncertainties in agricultural practice, with climate change the magnitude and frequency of stresses and shocks are changing (Davies et al. 2009).¹ Arguably, such responses to disasters may result in farmers either moving away from farm to nonfarm employment, which will reduce their future vulnerability to disaster, or intensifying agricultural activities in order to compensate for the lost income.

Typically, natural disasters force rural households and farmers to adopt coping and adaptation strategies such as crop switching, increased labor supply and land transactions (sell land or rent for use)—within the same area—or sale of productive assets and temporary migration—to another area (e.g., Duflo 2003; Jensen 2000; Moniruzzaman 2015; Penning-Rowsell, Sultana, and Thompson 2013; Banerjee 2007; Mueller and Quisumbing 2011; Eskander and Barbier 2016; Bryan, Chowdhury, and Mobarak 2014). While disaster-affected people may decide to migrate to less disaster-prone regions (e.g., Boustan, Kahn, and Rhode 2012; Hornbeck 2012), migration to urban areas is conditional on a household's ability to find alternative employment while facing liquidity constraints. For example, Bryan, Chowdhury, and Mobarak (2014) identified that rural households in Bangladesh respond to incentives that relax their liquidity constraint when making seasonal migration decision during the lean

¹ Indeed, the rising global temperature is leading to more frequent extreme weather events such as droughts, floods, storms, and heat waves. In particular, the numbers of such intense calamities are not only higher in developing Asia than in any other region, but they are also increasing (Thomas et al. 2013). Bangladesh, Cambodia, India, Pakistan, the Philippines, and Viet Nam, are among the countries that are heavily exposed to such events. By changing the pattern of occurrence of disasters, such trends have made it more difficult to anticipate disasters.

period.² However, Bohra-Mishra, Oppenheimer, and Hsiang (2014) analyzed province-to-province movement of more than 7,000 households in Indonesia over 15 years to find that while there can be a nonlinear permanent migration response to climatic variations, the evidence of permanent migration is minimal among the disaster-affected households. In the case of Bangladesh, Penning-Rowsell, Sultana, and Thompson (2013) found that permanent migration is an unlikely response of rural people who are less likely to migrate even in the face of extreme disasters, although they may temporarily migrate to safer places;³ whereas Mueller, Gray, and Kosec (2014) found that floods have modest to insignificant impacts on long-term migration in Pakistan. Consistent with this argument, Eskander and Barbier (2016) found that disaster-affected rural households instead intensify agricultural activities by increasing their operational farm size through increased transactions in the land rental market.

Rural farmers may change their savings behavior either in response to disaster exposure or in preparation for combating the harms of future disasters. Although forward-looking agents usually save in order to smooth their consumption during disasters, the high frequency of natural disasters in both Bangladesh and Pakistan often adversely affects the accumulation of cash savings in the period between two disasters. Especially for the poor farming households, the recovery may take longer and they might focus on investing in productive assets such as bullocks for crop cultivation rather than cash savings. In fact, the poor farmers often set their primary focus on meeting immediate subsistence needs while experiencing frequent events of disaster and, therefore, may not be able to save to combat any future risk of disasters.

Harmful effects of disaster are further heightened in the case of low-income countries such as Bangladesh and Pakistan (Field et al. 2012). Insurance programs, which are often scarce in rural areas of low-income countries, to protect life, property, and agricultural crop fail when large numbers of clients are simultaneously affected by a disaster. In particular, farming households from low-income countries are often left with fewer means to invest in protection to reduce risks of natural disasters and in insurance to reduce possible losses from such disasters.^{4,5} Moreover, exposure to disasters and adaptation practices leave longer-lasting impacts on income and savings of disaster-exposed households. It is for such reasons that Sustainable Development Goal 13 (Climate Action) emphasizes the need to strengthen resilience and adaptive capacity to climate-related hazards and natural disasters.

Against this backdrop, this paper investigates the impact of natural disasters on economic behavior. It explores two questions in particular: (i) Do disaster-affected farmers move away from agriculture for employment and income in comparison to unaffected households? And (ii) Do disaster-affected farmers have a lower increase in their savings than the unaffected households? Our empirical analysis identifies that disaster-affected farmers and nonfarmers in Bangladesh increase respectively their nonfarm and farm labor supply, whereas such adjustments are stronger among the storm-affected households than the flood-affected households. On the other hand, although farmers

² Consistent with this result, Cattaneo and Peri (2016) found that in low-income countries a temperature increase decreases migration and traps people into poverty.

³ This tendency is historically true for Bangladesh. For example, even the people affected by the great 1970 Bhola cyclone did not migrate permanently (Sommer and Mosley 1972).

⁴ The losses from natural disasters in low-income countries amounted to 0.3% of gross domestic product (GDP) during 2001–2006. However, such loss values are lower-bound estimates due to difficulties in monetizing many subjective losses (Field et al. 2012, 7).

⁵ In 2012, 47% of the population of low-income countries (2014 gross national income per capita \$1,045 or less) still lived on less than \$1.9 (2011 purchasing power parity) a day per capita, and 74% lived on less than \$3.1 (2011 purchasing power parity) a day per capita (World Bank 2015).

in Pakistan immediately move away from agriculture, they eventually come back within a year of disaster exposure. Therefore, such changes in employment and income strategies may not necessarily imply a structural change; however, they do imply a household's success in coping with the harms of disaster since the disaster-affected households from both Bangladesh and Pakistan were able to maintain at least a nondecrease in their levels of savings.

The content of the remainder of this paper is as follows. Section II provides the background of exposure to natural disasters for the case of Bangladesh and Pakistan and develops a simple model to capture its income effects for an agricultural economy. Section III describes data and variables used for empirical analysis in this paper. Section IV specifies the empirical model. Section V reports and discusses the regression results. Finally, Section VI summarizes the discussion and concludes.

II. BACKGROUND AND EMPIRICAL STRATEGY

This paper explores household-level responses to extreme weather events in Bangladesh and Pakistan, which are among the most disaster-prone countries in the world. In particular, the frequency of extreme floods is on the rise in Bangladesh and Pakistan (Mirza 2011). During 2000–2015, Bangladesh experienced a total of 29 floods and 40 storms, resulting in nearly 8,000 deaths and \$5,600 million in losses from damage to property, crops, and livestock (EM-DAT 2016). During the same period, Pakistan experienced a total of 45 floods and five storms, resulting in nearly 6,000 deaths and \$20,700 million in losses (EM-DAT 2016). These two countries today host populations of similar sizes and share the same history, having been carved out of a unified country that existed during 1947–1971. The agriculture sector, the primary victim of climatic extremes, contributes a similar share of gross domestic product (GDP) in the two countries. Their shared history and comparable socioeconomic characteristics make Bangladesh and Pakistan suitable comparators to explore the adaptation responses by households.

We develop a simple model of disaster exposure to capture its income effects for an agricultural economy. Predisaster farm and nonfarm incomes of the representative household are q_1^f and q_1^{nf} , respectively. Therefore, predisaster household income is $(q_1^f + q_1^{nf})$.

A disaster takes place between two survey years $t = 1$ and $t = 2$ which affects some of the rural households. For the unaffected households, postdisaster farm and nonfarm incomes are q_2^f and q_2^{nf} , respectively, so that their postdisaster household income is $(q_2^f + q_2^{nf})$. Change in the dependence on agriculture for the unaffected households is

$$\Delta A^u = \frac{q_2^f}{q_2^f + q_2^{nf}} - \frac{q_1^f}{q_1^f + q_1^{nf}}, \quad (1)$$

where $\frac{q_1^f}{q_1^f + q_1^{nf}}$ and $\frac{q_2^f}{q_2^f + q_2^{nf}}$ denote the pre and postdisaster dependence on agriculture of the unaffected households. In particular, $\Delta A^u > 0$ implies increased dependency on farm income, $\Delta A^u < 0$ implies decreased dependency on farm income, and $\Delta A^u = 0$ implies no change in dependency.

For the affected households, let us assume that α^f and α^{nf} are the percentage of farm and nonfarm incomes lost due to disaster exposure. Therefore, postdisaster farm and nonfarm incomes for the affected households are $(1 - \alpha^f)q_2^f$ and $(1 - \alpha^{nf})q_2^{nf}$, respectively, and their postdisaster

household income is $((1 - \alpha^f)q_2^f + (1 - \alpha^{nf})q_2^{nf})$. Change in the dependence on agriculture for the affected households is

$$\Delta A^a = \frac{(1 - \alpha^f)q_2^f}{(1 - \alpha^f)q_2^f + (1 - \alpha^{nf})q_2^{nf}} - \frac{q_1^f}{q_1^f + q_1^{nf}}, \quad (2)$$

where $\frac{q_1^f}{q_1^f + q_1^{nf}}$ and $\frac{(1 - \alpha^f)q_2^f}{(1 - \alpha^f)q_2^f + (1 - \alpha^{nf})q_2^{nf}}$ denote the pre and postdisaster dependence on agriculture of the affected households. In particular, $\Delta A^a > 0$ implies increased dependency on farm income, $\Delta A^a < 0$ implies decreased dependency on farm income, and $\Delta A^a = 0$ implies no change in dependency.

We assume that exposure to natural disasters definitely lowers farm income ($\alpha^f > 0$), but may or may not lower nonfarm income ($\alpha^{nf} \geq 0$). In addition, consistent with the literature, we also assume that disasters harm farm income more than nonfarm income ($\alpha^f > \alpha^{nf}$). However, when identifying the effect of disaster exposure on the change in the dependence on agriculture, there are three possibilities:

- (i) Increase the dependence on agriculture: $\Delta A^a - \Delta A^u > 0$. This situation can happen when we have either $\Delta A^a \geq \Delta A^u \geq 0, \Delta A^a > \Delta A^u$ or $\Delta A^a \leq \Delta A^u \leq 0, |\Delta A^a| < |\Delta A^u|$.
- (ii) Decrease the dependence on agriculture: $\Delta A^a - \Delta A^u < 0$. This situation can happen when we have either $\Delta A^a \geq \Delta A^u \geq 0, \Delta A^a < \Delta A^u$ or $\Delta A^a \leq \Delta A^u \leq 0, |\Delta A^a| > |\Delta A^u|$.
- (iii) No change in the dependence on agriculture: $\Delta A^a - \Delta A^u = 0$. This situation can happen when we have either $\Delta A^a \geq \Delta A^u \geq 0, \Delta A^a = \Delta A^u$ or $\Delta A^a \leq \Delta A^u \leq 0, |\Delta A^a| = |\Delta A^u|$.

In addition, assuming that any adjustment farmers make to their income and employment strategies are intended to overcome the harms of disaster, we can use the consequent changes in their savings behavior as a measure of success of their coping strategies. Since income determines a household's savings behavior, we expect to observe a similar pattern of change in income and employment strategies as well as savings behavior.

Since the direction of change in the dependence on agriculture in response to disaster exposure is uncertain from the conceptual framework developed in this section, it requires empirical investigation. In this paper, we empirically investigate the direction of change in the dependence on agriculture for Bangladesh and Pakistan, both of which are among the worst sufferers of natural disasters such as floods and storms. First, geographic location and land characteristics make Bangladesh one of the most disaster-prone countries in the world: 26% of the population of Bangladesh is affected by cyclones and 70% live in flood-prone regions (Cash et al. 2014), while almost the entire population of Bangladesh lives in areas of high mortality risk due to exposure to natural disasters (Dilley 2005).⁶ Bangladesh tops the list of Asian developing countries at relatively high

⁶ Wide-scale flooding has been the most recurrent type of disaster striking Bangladesh, and the country remains one of the worst sufferers of cyclone casualties in the world. Large natural disasters with profound impacts on lives and livelihoods striking Bangladesh include the 1970 cyclone, 1986 flood, 1991 cyclone, 1998 flood, and 2007 and 2009 cyclones. Apart from these major disasters, there were many smaller disasters with considerable harmful effects. Table A1 lists the storms and floods from 2010 to 2013 when total casualties reached around 400 from exposure to nine cyclonic storms and five floods, whereas these natural disasters affected more than 10 million people from different regions of Bangladesh (EM-DAT 2016). Agriculture, which employed around 44% of the labor force in Bangladesh and contributed around 20% of its GDP in 2009 (BBS 2010), is the primary victim of these disasters.

mortality risk and is second on the list of Asian developing countries at relatively high economic risk from multiple hazards (ADB 2013). We are particularly interested in the exposure to disasters taking place during 2011–2012, i.e., the time between the two rounds of the Bangladesh Climate Change Adaptation Survey (BCCAS) dataset collected. Between February 2011 (when BCCAS I was completed) and September 2012 (when BCCAS II was started), Bangladesh experienced two floods and two storms (IFPRI 2014a, 2014b). The flood of 21 July 2011 covered 21 districts of Bangladesh; however, the effect was rampant in the southeastern region. In particular, more than 20,000 people lost their homes due to heavy flooding in Cox’s Bazar district. In addition, rain-triggered landslides caused 17 deaths in adjoining Chittagong district. The same region was hit by the flood of 4 June 2012, which resulted in 139 deaths and affected more than 5 million people (Appendix 1, Table A1.1). Between these floods, two cyclonic storms struck Bangladesh in April 2011 and April 2012. The 2011 storm mainly affected the northwestern districts, resulting in 13 deaths, whereas the 2012 storm caused 25 deaths in southwestern districts.

Next, a diverse terrain, ranging from mountains in the north to floodplains and deserts in the south, makes Pakistan vulnerable to natural disasters. Especially the floodplains of the Indus River in the southeast experience recurrent events of flood, such as the floods during 2010–2012.⁷ Similar to Bangladesh, agriculture constitutes the largest sector of Pakistan’s economy: it contributes about 24% of GDP and employs around half of the labor force (PBS 2016). Pakistan ranks seventh on the list of Asian developing countries at relatively high mortality risk and 11th on the list of Asian developing countries at relatively high economic risk from multiple hazards (ADB 2013). In this paper, we are particularly interested in the exposure to disasters taking place during 2012–2013, i.e., the time between the two rounds of the Pakistan Rural Household Panel Survey (PRHPS) dataset collected. Between May 2012 (when PRHPS I was completed) and March 2013 (when PRHPS II was started), the 2012 August flood resulted in 480 deaths and affected more than 5 million people from Balochistan, Punjab, and Sindh provinces (IFPRI and IDS 2014, 2016). In particular, the affected districts were Jaffarabad, Jhal Magsi, and Nasirabad in Balochistan; DG Khan and Rajanpur in Punjab; and Dadu, Ghotki, Jacobabad, and Larkana in Sindh (EM-DAT 2016).

⁷ The 2010 Pakistan floods affected the Indus River basin across the provinces of Khyber Pakhtunkhwa, Sindh, Punjab, and Balochistan. Beginning in late July 2010, this flood affected approximately a fifth of Pakistan’s total land area, affecting about 20 million people and resulting in a total of around 2,000 deaths and estimated damages of \$9,500 million (EM-DAT 2016). On the other hand, just a year after the 2010 floods, the Pakistani province of Sindh experienced another widespread flood during August–November 2011. In addition to more than 500 deaths, the 2011 flood affected more than 5 million people and resulted in estimated damages of \$2,500 million (EM-DAT 2016). These two major floods in 2010 and 2011 affected most of the districts of Khyber Pakhtunkhwa, Sindh, and Punjab, which are the provinces covered in PRHPS I and II. Altogether, 10 floods and one tropical storm struck Pakistan during 2010–2014, resulting in around 3,500 deaths in addition to affecting over 32 million people (EM-DAT 2016). Appendix 1, Table A1.2 lists natural disasters in Pakistan during 2010–2013.

III. DATA AND VARIABLES

A. Bangladesh Climate Change Adaptation Survey

For the case of Bangladesh, we use two rounds of the Bangladesh Climate Change Adaptation Survey (BCCAS) dataset. The survey, funded by the United States Agency for International Development (USAID), was designed and supervised by the International Food Policy Research Institute and administered by the Bangladesh Centre for Advanced Studies, Dhaka, Bangladesh. It covered 40 randomly selected unions to represent the seven broad agroecological zones as grouped by the Bangladesh Centre for Advanced Studies.⁸ Twenty agricultural households were randomly selected from a single village in each union, creating a sample of 800 households. The first round of the survey, BCCAS I, was conducted from December 2010 to February 2011, whereas the second round, BCCAS II, was conducted from September to October 2012. Each survey covers data from the previous production year 2010 and 2012, respectively. More than 97%, or 766 out of 800 households, from BCCAS I were reinterviewed in BCCAS II. The survey captures information on demographic characteristics, social capital, land tenure, crop and livestock management, input use, extension, incidence of climatic shocks in the last 5 years, and adaptation options (Thomas et al. 2013).

Table 1 describes and summarizes the variables we use in the empirical analysis of this paper for Bangladesh. The BCCAS dataset reports information, among others, on a household's exposure to natural disasters in between the two survey years. We are particularly interested in household-specific reporting of exposure to floods and storms which affect 22% and 9% of households, respectively.

Table 1: Baseline Summary Statistics, Bangladesh

Variable	Description	Mean	S.D.	Min.	Max.
Flood	Dummy: 1 if exposed to floods in 2011, 0 if not	0.22	0.41	0	1
Storms	Dummy: 1 if exposed to storms in 2011, 0 if not	0.05	0.21	0	1
Farmworkers	Number of 14+ farmworkers in the household in 2010	0.92	0.73	0	4
	Number of 14+ farmworkers in the household in 2012	0.85	0.75	0	4
Nonfarmworkers	Number of 14+ nonfarmworkers in the household in 2010	0.54	0.79	0	4
	Number of 14+ nonfarmworkers in the household in 2012	0.56	0.74	0	4
New livestock	Market value of purchased livestock in the last year, 2010 (\$)	90	141	0	1,170
	Market value of purchased livestock in the last year, 2012 (\$)	3	2	0	7
Farmer	Dummy: 1 if primarily a farming household, 0 if otherwise	0.70	0.46	0	1
Age	Age of the household head (in completed years)	45.35	13.53	17	95
Household size	Size of the household	4.88	1.99	1	22
Education	Average years of schooling in the household	3.46	2.44	0	12.33
Males	Number of working age, aged 15–65, males in the family	1.49	0.93	0	6
Females	Number of working age, aged 15–65, females in the family	1.54	0.78	0	7
Tractor	Dummy: 1 if owns a tractor or a plow–yoke, 0 if not	0.24	0.43	0	1
Irrigation pump	Dummy: 1 if owns a pump or well for irrigation, 0 if not	0.08	0.27	0	1
Other assets	Dummy: 1 if owns other agricultural assets, 0 if not	0.71	0.45	0	1
Electricity	1 if the household has electricity connection, 0 if not	0.47	0.50	0	1
Farm size	Amount of agricultural land operated by the household (acres)	1.38	3.04	0	71.78
Unpaid loan	Amount of unpaid loan, 2010 (\$)	186	750	0	12,754
Number of observations		766			

Source: Summary statistics are based on the Bangladesh Climate Change Adaptation Survey (BCCAS), Rounds I and II.

⁸ The seven agroecological zones are Barind Tract, tidal floodplains, Modhupur tract, Himalayan piedmont plain, beel and haor basins, northern and eastern hills, and floodplains.

The BCCAS dataset contains information on farm and nonfarm labor supplies, which form our outcome variable. Note that we restrict figures to members aged above 14 years when calculating labor supplies. Table 1 shows that average number of farmworkers falls from 0.92 in 2010 to 0.85 in 2012, whereas the average number of nonfarmworkers increases from 0.54 to 0.56. On the other hand, we use household spending on the purchase of new livestock as a measure of savings in the absence of a direct measure. In 2010, surveyed households spent \$90 on the purchase of new livestock, whereas this amount considerably dropped to only \$3 in 2012.

In addition, Table 1 provides baseline summary statistics from the BCCAS I dataset, with particular focus on household- and farm-level characteristics. Most of the household heads are primarily farmers (70%). On average, household heads are 45.21 years old and household members have 3.46 years of schooling. The average household size is 4.85, which comprises 1.49 working-age males and 1.54 working-age females (aged between 15 and 65 years).

The average operational farm size, defined as the sum of owned-operated and rented-operated land, is 1.38 acres. Among the surveyed households, 24% own a tractor or plow-yoke (i.e., the means of cultivation), whereas 8% own an irrigation pump and 71% own other agricultural assets. Furthermore, 47% of households have an electricity connection and they have \$173 in unpaid loans.

B. Pakistan Rural Household Panel Survey (PRHPS)

For the case of Pakistan, we use two rounds of the PRHPS dataset. The survey funded by United States Agency for International Development was designed and supervised by the International Food Policy Research Institute and administered by Innovative Development Strategies. The sample is nationally representative of the rural areas of the three provinces: Punjab, Sindh, and Khyber Pakhtunkhwa. The first round of the survey, PRHPS I, was completed in April 2012, covering a total of 2,090 households in 76 primary sampling units in the rural areas of these three provinces, and the second round, PRHPS II, was conducted from April to May 2013, which reinterviewed 2,002 of the 2,090 households surveyed in PRHPS I. Information on 88 households could not be collected because they refused to respond, had migrated, or were not available. Each survey covers data from the previous production year 2011 and 2012, respectively, on a large number of topics such as sources of income, consumption patterns, time use, assets and savings, loans and credit, education, migration, economic shocks, participation in social safety nets, and household aspirations.

The PRHPS dataset defines nonagricultural households as those without any agricultural income. Since we are investigating structural change from agriculture to nonagriculture with a special focus on agricultural households, we restrict our estimating sample to 980 agricultural sample households, all of whom were reinterviewed in 2013.

Table 2 describes and summarizes the variables we use in the empirical analysis of this paper for Pakistan. Data on exposure to natural disasters come from the EM-DAT database, which reveal that the floods of 2011 and 2012 affected 23% and 19% households, respectively.

The PRHPS dataset contains information on farm and nonfarm income, which form our outcome variable. Table 2 shows that the average farm income falls from \$1,978 in 2011 to \$4 in 2012, whereas nonfarm income falls from \$5 in 2011 to \$2 in 2012. Cash savings fall from \$126 to \$1, whereas spending on the purchase of new livestock dropped from \$23 to \$0.29 over the same period.

Table 2 provides baseline summary statistics from PRHPS I, with particular focus on household- and farm-level characteristics. On average, household heads are 46.43 years old and household members have 4.39 years of schooling. The average household size is 6.68, which comprises 1.9 working-age males and 1.82 working-age females (aged 15–65 years).

Table 2: Baseline Summary Statistics, Pakistan

Variable	Description	Mean	S.D.	Min.	Max.
Flood 2012	Dummy: 1 if affected by flood 2012, 0 if not	0.19	0.39	0	1
Flood 2011	Dummy: 1 if affected by flood 2011, 0 if not	0.23	0.42	0	1
Farm income	Total agricultural income net of costs in 2011 (\$)	1,978	4,447	0	56,814
	Total agricultural income net of costs in 2012 (\$)	4	3	0	12
Nonfarm income	Total nonagricultural income in 2011 (\$)	5	119	0	2,861
	Total nonagricultural income in 2012 (\$)	2	3	0	10
Savings	Total savings in 2011 (\$)	126	879	0	16,503
	Total savings in 2012 (\$)	1	2	0	9
New livestock	Market value of purchased livestock in the last year, 2011 (\$)	23	122	0	1,210
	Market value of purchased livestock in the last year, 2012 (\$)	0.29	1	0	8
Age	Age of the household head (in completed years)	46.43	13.57	18	92
Household size	Size of the household	6.68	3.25	2	35
Education	Average years of schooling in the household	4.39	4.25	0	17
Males	Number of working-age, aged 15–65, males in the family	1.90	1.27	0	9
Females	Number of working-age, aged 15–65, females in the family	1.82	1.20	0	8
Tractor	Dummy: 1 if owns a tractor or a plow–yoke, 0 if not	0.13	0.34	0	1
Irrigation pump	Dummy: 1 if owns a pump or well for irrigation, 0 if not	0.25	0.43	0	1
Other assets	Dummy: 1 if owns other agricultural assets, 0 if not	0.62	0.49	0	1
Electricity	1 if the household has electricity connection; 0 if otherwise	0.83	0.38	0	1
Farm size	Amount of agricultural land owned by the household (acres)	5.68	7.77	0	80
Unpaid loan	Amount of unpaid loan, 2010 (\$)	306	911	0	11,057
Number of observations		980			

Source: Summary statistics are based on the Pakistan Rural Household Panel Survey (PRHPS) 2012, Rounds I and II.

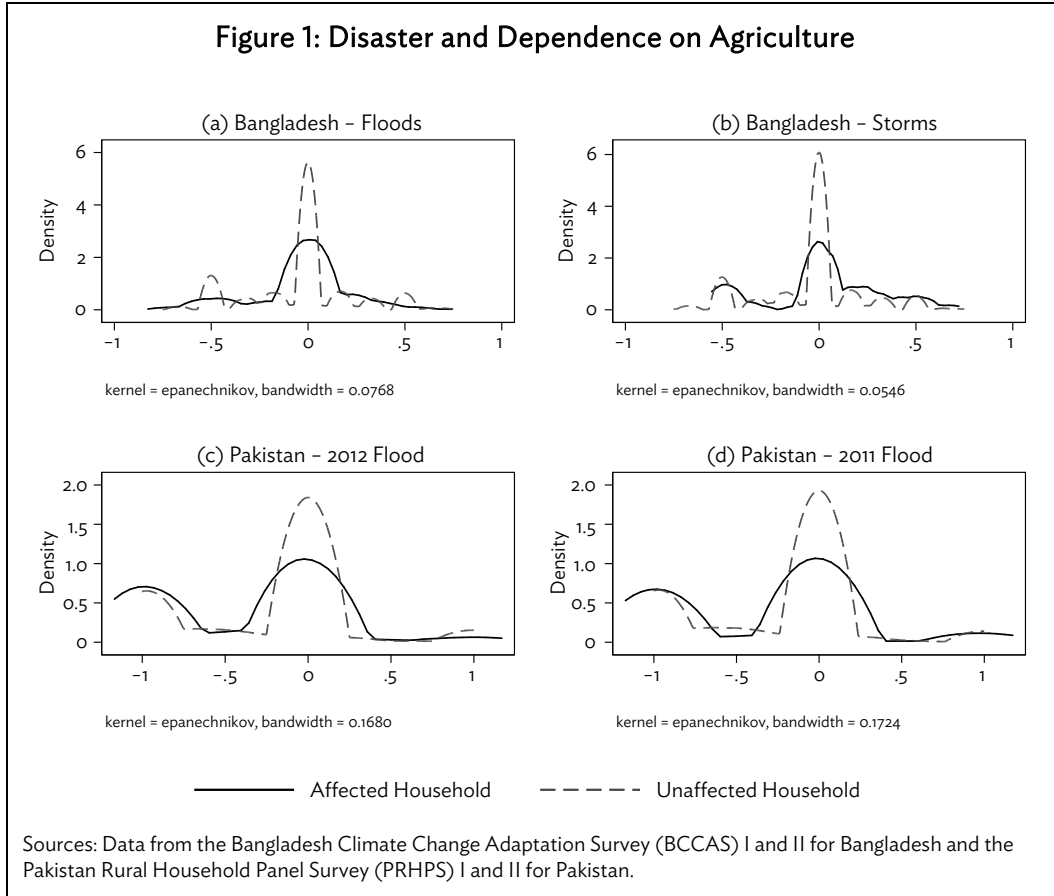
The average operational farm size is 5.68 acres. Among the households, 13% own a tractor or plow–yoke (i.e., the means of cultivation), whereas 25% own an irrigation pump and 62% own other agricultural assets. Furthermore, 83% of households have an electricity connection and they have \$306 in unpaid loans.

IV. EMPIRICAL SPECIFICATION

We evaluate whether variations in disaster exposure predict structural change among the agricultural households from Bangladesh and Pakistan. Structural change refers to a household's dependence on farm and nonfarm employment and income: we hypothesize that households may exhibit accelerated movement from the farm to the nonfarm sector for employment and income in response to disaster exposure. Since absolute changes in farm and nonfarm employment may not necessarily reflect a household's movement between sectors due to potential changes in the number of working-age members between the survey years, we investigate whether there is a change in the dependence on agriculture due to disaster exposure. The structural change for household i due to disaster exposure is estimated as

$$\Delta a_{it} = g(D_{it}, x_i, \delta, \epsilon_{it}), \quad (3)$$

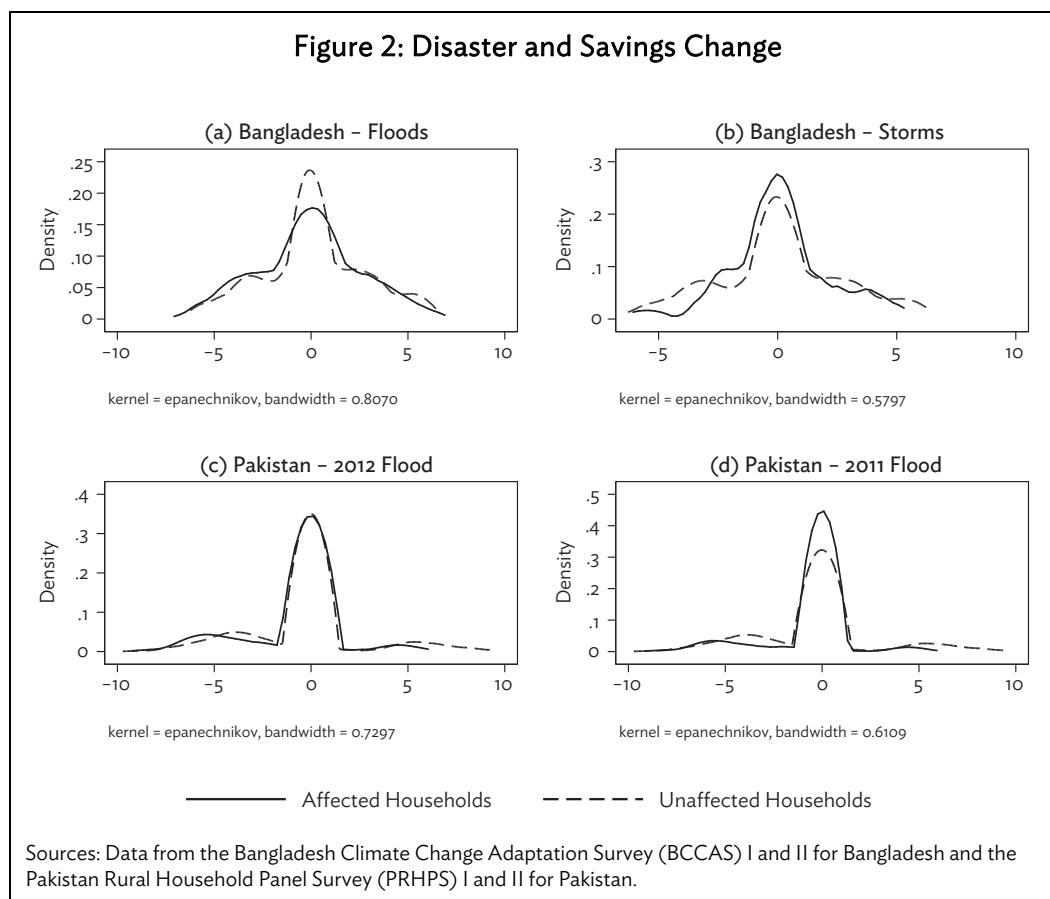
where $\Delta a_{it} = a_{i2} - a_{i1} \forall i$ denotes the structural change, with a_{i1} and a_{i2} denoting the dependence on agriculture in years 1 and 2, respectively, and $\Delta a_{it} > 0$ and $\Delta a_{it} < 0$ implying increased and decreased dependence on agriculture as a result of disaster exposure. More precisely, we define structural change in terms of employment for the case of Bangladesh as $\Delta a_{it} = \frac{l_{i2}^f}{l_{i2}^f + l_{i2}^n} - \frac{l_{i1}^f}{l_{i1}^f + l_{i1}^n}$, where l_{it}^f and l_{it}^n denote the shares of farm and nonfarm employment of Bangladeshi households in 2010 ($t = 1$) and 2012 ($t = 2$). Panels A and B in Figure 1 show that disaster-affected households from Bangladesh have a higher change in their dependence on agriculture than the unaffected households. On the other hand, we define structural change in terms of income for the case of Pakistan as $\Delta a_{it} = \frac{y_{i2}^f}{y_{i2}^f + y_{i2}^n} - \frac{y_{i1}^f}{y_{i1}^f + y_{i1}^n}$, where y_{it}^f and y_{it}^n denote the shares of farm and nonfarm incomes of Pakistani households in 2011 ($t = 1$) and 2013 ($t = 2$). Similar to Bangladesh, panels C and D in Figure 1 show that disaster-affected households from Pakistan have a higher change in their dependence on agriculture than the unaffected households. In both cases, we only consider the household members aged 15 years or older when calculating these outcome variables.



Next, we evaluate whether variations in disaster exposure predict the magnitude of the changes in savings by Bangladeshi and Pakistani households according to:

$$\Delta s_{it} = h(D_{it}, x_i, \delta, \varepsilon_{it}), \quad (4)$$

where $\Delta s_{it} = s_{i2} - s_{i1} \forall i$ is the change in savings, with s_{i1} and s_{i2} denoting logged (one plus) annual savings in years 1 and 2, respectively, and $\Delta s_{it} > 0$ and $\Delta s_{it} < 0$ implying increased and decreased savings as a result of disaster exposure. Panels A–D in Figure 2 show that disaster-affected households from Bangladesh and Pakistan have similar changes in their savings behavior compared to the unaffected households.



Our empirical approaches to estimating equations (3) and (4) involve specifying the components of the vectors D_{it} and x_i . Vector D_{it} includes our variables of interest defining the disaster exposure of a household between the survey years and will be specified for Bangladesh and Pakistan separately in the following sections. In addition, vector x_i includes the base year household- and farm-level characteristics affecting farm and nonfarm employment, income, and savings opportunities. A household is defined to include the number of people that dine-in together from the same pot. Household characteristics include the age and squared age of the household head, size and squared size of the household, average years of schooling of all the household members, number of working-age males and females in the household (defined as the number of males and females aged between 15 and 65 years), credit constraint (defined as logged one plus unpaid loans of the household), and access to facilities defining their relative entitlement such as access to electricity (defined as 1 if the household has access to electricity connection and 0 if not). On the other hand, farm-level characteristics include ownership of a tractor (1 if the household owns a tractor or a plow-yoke, 0 if not), an irrigation pump (1 if the household owns an irrigation pump, 0 if not), and other agricultural assets (1 if the household owns other agricultural assets, 0 if not), as well as operational farm size (natural log of one plus acres of owned-operated and rented-operated land). Finally, δ represents the

location vector. Within a cohort, future effects of disaster exposure should be common to all households and individuals born in the same locality (e.g., Almond, Edlund, and Palme 2009; Maccini and Yang 2009). Therefore, variations in employment, income, and savings resulting from the variations in location of residence should be absorbed by δ , which controls for persistent effects of disaster exposure on the regions and households.

V. RESULTS AND DISCUSSIONS

A. Bangladesh

In BCCAS II, surveyed households report whether they were exposed to natural disasters such as floods and storms during 2011. Based on this reporting, we consider two separate measures of exposure by the type of disaster: (i) exposure to floods only and (ii) exposure to storms only. In both cases, a household's self-reported disaster exposure is defined as 1 if exposed to a disaster and 0 if not. In addition, since farmers and nonfarmers may experience different degrees of severity in the aftermath of a disaster, we interact these measures of disaster exposure with their primary occupation, which we define as 1 if the household head is primarily a farmer (i.e., a primarily farming household) and 0 if otherwise (i.e., a household who does farming but not primarily a farming household). Therefore, for Bangladesh, we evaluate whether variations in disaster exposure and primary occupation predict the magnitude of the changes in employment and savings behaviors by Bangladeshi households.

Columns 1 and 2 in Table 3 report the regression results based on equation (3) for flood and storm exposure in Bangladesh, with corresponding R^2 values of 0.107 and 0.1, respectively. We do not report the *thana* (location) dummies in any of the regression tables; however, they are available upon request. In addition, although we report the parameter estimates of control variables, we confine our discussion of results only to the parameters of interest. As shown in Appendix 2, Table A2.2, estimates of our parameters of interest are similar without the control variables, therefore supporting our claim that the change in Bangladeshi households' employment strategy and savings behavior comes from disaster exposure.

In general, disaster exposure increases dependence on agriculture. We find that flood-affected households have an 18.2% higher proportion of farm employment than flood-unaffected households. Further, storm-affected households have a 29.3% higher proportion of farm employment than storm-unaffected households. However, disaster-affected farmers lower their dependence on agriculture more than unaffected nonfarmers. Our results show that flood- and storm-affected farmers have 18.1% and 32.9% lower proportions of farm employment than their corresponding unaffected counterparts. Together, these results indicate a structural change from nonfarm to farm employment in general, and farm to nonfarm for the farming households.

These results are consistent with the existing literature on the comparison between agricultural and nonagricultural labor supply in the aftermath of a disaster. While natural disasters such as flooding increase households' vulnerability to poverty (Khandker 2007), flood-affected households who increase their nonfarm labor supply cope better due to higher receipts of wages from nonfarm than farm employment (e.g., Banerjee 2007; Mueller and Quisumbing 2011). Therefore, given that rational households are motivated by income maximization when making labor supply decisions, our results indicate that disaster-affected farmers move away from farm to nonfarm employment as a coping strategy to tackle short-term reductions in their total household income.

Table 3: Exposure to Disaster and Change in the Dependence on Agriculture

Variable	Bangladesh		Pakistan
	Floods	Storms	Floods
Flood	0.182*** (0.047)		
Farmer x Flood	-0.181*** (0.048)		
Storm		0.293*** (0.089)	
Farmer x Storm		-0.329*** (0.120)	
Flood 2012			-0.419*** (0.036)
Flood 2011			0.451*** (0.092)
Age	0.009** (0.004)	0.008** (0.004)	-0.007 (0.008)
(Age) ²	-0.000* (0.000)	-0.000* (0.000)	0.000 (0.000)
Household size	0.018 (0.036)	0.015 (0.037)	0.034 (0.052)
(Household size) ²	-0.002 (0.003)	-0.002 (0.003)	-0.002 (0.004)
Education	0.007 (0.005)	0.008 (0.005)	-0.010 (0.006)
Males	0.008 (0.015)	0.010 (0.014)	-0.009 (0.022)
Females	0.015 (0.014)	0.013 (0.015)	0.005 (0.021)
Tractor	-0.005 (0.025)	-0.003 (0.025)	-0.009 (0.047)
Irrigation pump	-0.026 (0.031)	-0.027 (0.030)	0.014 (0.050)
Other agricultural assets	0.040 (0.045)	0.027 (0.044)	-0.009 (0.056)
Electricity connection	-0.010 (0.022)	-0.017 (0.021)	0.116 (0.072)
Ln(Farm size)	0.187 (0.342)	0.124 (0.330)	-0.175 (0.284)
Credit constraint	0.002 (0.005)	0.002 (0.005)	-0.004 (0.006)
Observations	703	703	842
R ²	0.107	0.100	0.170

Notes: Standard errors clustered at the union level are shown in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Ordinary least squares regression coefficients are obtained from using equation (3). We do not report the *thana* or *tehsil* (location) dummies; however, they are available upon request. Regressions excluding the control variables yield similar coefficient estimates for our parameters of interest (Appendix 2, Table A2.3). Therefore, they justify that the change in the proportion of farm income comes from exposure to disaster.

Sources: All household data come from the Bangladesh Climate Change Adaptation Survey (BCCAS) I and II for Bangladesh and the Pakistan Rural Household Panel Survey (PRHPS) I and II for Pakistan.

Moreover, we further can predict that the compensating effects of such changes in employment strategies may be reflected in a household's savings behavior. Columns 1 and 2 in Table 4 report the regression results based on equation (4) for flood and storm exposure in Bangladesh, with corresponding R^2 values of 0.145 and 0.144, respectively. We define change in savings as $\Delta s_{it} = s_{i2} - s_{i1} \forall i$ in terms of livestock purchase, so that s_{i1} and s_{i2} denote logged (one plus) annual spending on the purchase of livestock by Bangladeshi households in 2010 ($t = 1$) and 2012 ($t = 2$). We find that flood-affected households have 50.7% lower savings than flood-unaffected households, whereas

storm-affected households have 67.1% lower savings than storm-unaffected households. In addition, flood- and storm-affected farmers have 39% and 42.2% higher savings than their corresponding unaffected counterparts. Together, although our parameters of interest are statistically insignificant, we find some evidence suggesting that disaster-affected household may be able to increase their savings as a consequence of successfully coping with the immediate harms of disaster.

Table 4: Exposure to Disaster and Savings Change

Variable	Bangladesh		Pakistan	
	Floods	Storms	Ln(Savings)	Ln(Livestock)
	Ln(Livestock)	Ln(Livestock)		
Flood	-0.507 (0.602)			
Farmer x Flood	0.390 (0.659)			
Storm		-0.671 (0.576)		
Farmer x Storm		0.422 (0.478)		
Flood 2012			0.819*** (0.156)	0.309*** (0.107)
Flood 2011			0.731* (0.435)	-0.089 (0.686)
Age	0.079 (0.048)	0.080 (0.048)	0.032 (0.049)	-0.008 (0.026)
(Age) ²	-0.001* (0.000)	-0.001* (0.000)	-0.000 (0.001)	0.000 (0.000)
Household size	-0.258 (0.301)	-0.253 (0.310)	-0.654*** (0.240)	-0.131 (0.170)
(Household size) ²	0.015 (0.025)	0.014 (0.026)	0.049** (0.019)	0.010 (0.013)
Education	0.014 (0.055)	0.013 (0.057)	0.014 (0.027)	0.003 (0.015)
Males	0.164 (0.133)	0.157 (0.129)	-0.047 (0.109)	-0.030 (0.053)
Females	0.045 (0.183)	0.053 (0.178)	-0.170 (0.110)	0.094 (0.095)
Tractor	-0.087 (0.331)	-0.094 (0.333)	0.033 (0.336)	-0.018 (0.246)
Irrigation pump	0.270 (0.510)	0.277 (0.505)	-0.583** (0.248)	-0.151 (0.149)
Other agricultural assets	0.158 (0.381)	0.189 (0.387)	0.331 (0.221)	-0.169 (0.215)
Electricity connection	-0.287 (0.256)	-0.285 (0.258)	-0.422 (0.293)	0.323* (0.192)
Ln(Farm size)	2.016 (3.067)	2.104 (3.296)	-0.387 (2.576)	-1.911** (0.905)
Credit constraint	0.025 (0.035)	0.027 (0.035)	-0.039 (0.031)	0.037* (0.021)
Observations	703	703	842	842
R ²	0.145	0.144	0.314	0.100

Notes: Standard errors clustered at the union level are shown in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. Ordinary least squares regression coefficients are obtained from using equation (3). We do not report the *thana* or *tehsil* dummies; however, they are available upon request. Regressions excluding the control variables yield similar coefficient estimates for our parameters of interest (Appendix 2, Table A2.3). Therefore, they justify that the changes in savings come from exposure to disaster. Sources: All household data come from the Bangladesh Climate Change Adaptation Survey (BCCAS) I and II for Bangladesh and the Pakistan Rural Household Panel Survey (PRHPS) I and II for Pakistan.

We also identify that the effects of exposure vary by the type of disaster. Clearly, the storm-affected households undergo a greater structural change than the flood-affected households, whereas storm-affected farmers have a greater reduction in their agriculture dependence than flood-affected farmers when they are compared to the corresponding unaffected farmers. Consistent with these employment effects of exposure, we also identify that the storm-affected households have a greater decrease in savings than the flood-affected households, whereas storm-affected farmers have a greater increase in their savings than flood-affected farmers when compared to corresponding unaffected farmers.

B. Pakistan

According to EM-DAT (2016), the 2010 Pakistan flood affected all the districts surveyed in the PRHPS. However, the floods of 2011 and 2012 that took place between PRHPS I and II affected four and three districts, respectively, out of 19 surveyed districts. Therefore, for the case of Pakistan, we include two dummy variables defining disaster exposure in the vector D_i : (i) Flood 2011 defined as 1 for the districts affected by the flood of 2011 (Dadu, Jacobabad, Hyderabad, and Sanghar districts in Sindh province) and 0 otherwise, and (ii) Flood 2012 defined as 1 for the districts affected by the flood of 2012 (DG Khan in Punjab province, and Dadu and Jacobabad in Sindh province) and 0 otherwise. Table 3 reports that 23% and 19% of surveyed Pakistani households were affected by 2011 and 2012 floods, respectively.

Column 3 in Table 3 reports the regression results based on equation (3) for flood exposure in Pakistan, with a corresponding R^2 value of 0.17. We do not report the *tehsil* (location) dummies in any of the regression tables; however, they are available upon request. In addition, although we report the parameter estimates of control variables, we confine our discussion of results only to the parameters of interest. As shown in Appendix 2, Table A2.2, estimates of our parameters of interest are similar without the control variables, therefore supporting our claim that the change in Pakistani households' income strategy and savings behavior comes from disaster exposure.

Results from Table 3 indicate that although Pakistani households change their income strategy in response to flood exposure, such changes are short-lived and do not necessarily imply a structural change. We find that the change in the dependence on agriculture differs by flood year. In particular, 2012 flood-affected farmers have a 41.9% decrease in their dependence on agriculture; however, the situation is exactly opposite for farmers affected by the 2011 flood who have a 45.1% increase in their dependence on agriculture.

The short-lived nature of the decrease in the dependence on agriculture is consistent with the existing literature on migration response to climatic change and climatic extremes in Pakistan showing that although rising temperatures increase rural–urban migration, and thereby lower the dependence on agriculture, floods do not significantly influence long-term migration in Pakistan (Mueller, Gray, and Kosec 2014). Although liquidity constraints may be responsible for their reluctance or inability to migrate permanently (e.g., Bryan, Chowdhury, and Mobarak 2014; Cattaneo and Peri 2016), guaranteed availability of humanitarian aid in response to climatic extremes such as floods and storms may also be responsible for slowing down the migration response to floods (e.g., Looney 2012; Strömberg 2007) and also for facilitating farmers' return to their ancestral location. On the contrary, but almost equal, the estimated magnitude of the effects of the 2011 and 2012 floods may also imply that such a return to ancestry happens within a year of flood exposure.

However, similar to the case of Bangladesh, such a return to ancestry may also imply Pakistani farmers' successful coping with the harms of flood exposure through temporary movement away from agriculture. Regressions investigating the savings effects of flood exposure in fact confirm this alternative implication of our estimated income effects of exposure to the 2011 and 2012 floods (see columns 3 and 4 in Table 4). Here, we use two different definitions of savings: logged one plus cash savings and logged one plus spending on the purchase of livestock, with s_{i1} and s_{i2} denoting savings by Pakistani households in 2011 ($t = 1$) and 2013 ($t = 2$). Both the 2011 and 2012 flood-affected farmers in Pakistan have a significantly higher increase in their savings than their corresponding unaffected counterparts, with this effect being stronger for the latter flood. In particular, we find that the 2011 flood results in a 73.1% increase in savings, whereas the 2012 flood increases savings by 81.9%.

C. Additional Results

Although absolute changes in farm and nonfarm employment and incomes may not always reflect a household's movement between sectors—since in the case of Bangladesh the number of working-age members may also change between the survey years and all the surveyed Pakistani households are farmers with zero nonfarm income in 2011—we employ a seemingly unrelated regression framework to provide additional results supporting our main results reported in Table 3. Simultaneously determined outcome variables are farm and nonfarm employments for Bangladesh and farm and nonfarm incomes for Pakistan.

Our results, as reported in Appendix 2, Table A2.1, reassure us that floods and storms cause households to increase farming and decrease nonfarming employment, therefore increasing the dependence on agriculture in general. On the other hand, flood- and storm-affected farmers have lower farming and higher nonfarming employment than unaffected nonfarmers, suggesting a decreased dependence on agriculture of the farming households in Bangladesh in response to disaster exposure. In addition, consistent with our main results in Table 3, we identify that the effects are stronger for storms than floods.

Consistent with Table 3, we also find that the 2012 and 2011 floods have quite different effects on Pakistani households in 2013: while the 2012 flood decreases agricultural income, households affected by the 2011 flood have a higher agricultural income than their unaffected counterparts. Together, these results support our main result implying that the changes in the composition of income due to disaster exposure may be temporary and do not necessarily imply a structural change.

VI. SUMMARY AND CONCLUSION

This paper identifies to what extent households in Bangladesh and Pakistan adjust their income and employment strategies and savings behavior in response to exposure to floods and storms. Farmers in Bangladesh move away from farm to nonfarm employment as a coping strategy to tackle immediate reductions in their total household income from exposure to disasters. On the other hand, although farmers in Pakistan move away from agriculture as an immediate response to disasters, they eventually come back to agriculture within a year of disaster exposure. Therefore, such changes in employment and income strategies may not necessarily imply a structural change. However, they do imply a household's success in coping with the harms of disaster: Disaster-affected households from both Bangladesh and Pakistan exhibit at least a nondecrease in their savings behavior.

Our empirical results carry important implications for developing countries with frequent exposure to natural disasters. The reduced dependence on farm income as a consequence of disaster exposure has two alternative policy implications. First, it might imply the persistence of income vulnerability of the farming households in case they experience lower farm and nonfarm incomes due to disaster exposure. Since rural households may respond to incentives to migrate (Bryan, Chowdhury, and Mobarak 2014), public policies should aim at financing the economic migration of disaster-affected rural households in order to reduce their income vulnerability. Second, the short-lived nature of such movement between farm and nonfarm sectors may imply the status quo is motivated by reverse incentive in the form of guaranteed access to humanitarian aid in the aftermath of a climatic extreme such as a flood or storm. Since the number of farmers and rural households who do not permanently migrate in response to natural disasters may not accelerate (Penning-Rowsell, Sultana, and Thompson 2013; Mueller, Gray, and Kosec 2014) and farmers usually intensify their agricultural activities to compensate for their lost income (e.g., Eskander and Barbier 2016), a sustainable structural change in order to facilitate economic growth requires the development of nonfarm employment opportunities in rural areas.

Reduced savings in the aftermath of a disaster is a rational response to the destruction of assets and a changed economic outlook, which affects the potential economic growth of an economy (e.g., Fankhauser and Tol 2005). However, disaster-affected farmers from both countries were successful in overcoming their losses. We find that disaster-affected households in Pakistan actually have a higher increase in their savings than unaffected households, whereas disaster-affected households in Bangladesh maintain similar savings. However, since bullocks are commonly used for cultivation in both countries, such increases in livestock purchases may actually imply that farmers invest in the accumulation of productive assets in order to revive their postdisaster agricultural activities. In addition to public financing of the postdisaster reconstruction, this is an example of farmers' private financing of the reconstruction process.

APPENDIX 1: LIST OF DISASTERS

Table A1.1: List of Natural Disasters in Bangladesh, 2010–2013

Disaster No.	Disaster Type	Date Started	Totals Deaths	Total Affected	Affected Regions (Districts)
2010-0171	Storm	13 Apr 2010	8	247,110	Rangpur, Dinajpur, Nilphamari, Lalmonirhat, Kurigram, Gaibandha, Sirajganj, Bogra
2010-0205	Storm	17 Apr 2010	3	10,000	Lalmonirhat
2010-0269	Flood	24 Jun 2010		75,000	Sylhet, Moulvibazar, Sunamganj, Habiganj, Netrokona, Kurigram, Gaibandha, Lalmonirhat
2010-0676	Flood	1 Oct 2010	15	500,000	—
2010-0686	Storm	1 May 2010	15	50	Mymensingh
2011-0262	Flood	21 Jul 2011	10	1,570,559	Chittagong, Cox's Bazar, Satkhira, Jessore, Narail, Bagerhat, Chuadanga, Kustia, Bogra, Sirajganj, Pabna, Lalmonirhat, Thakurgaon, Kurigram, Sherpur, Netrokona, Bandarban, Rajbari, Manikganj, Gaibandha, Naogaon
2011-0591	Storm	4 Apr 2011	13	121	Sherpur, Mymensingh, Rangpur, Thakurgaon, Jamalpur, Netrokona, Gaibandha, Pabna
2012-0082	Storm	6 Apr 2012	25	55,121	Satkhira, Jessore, Chuadanga, Panchagarh, Noakhali, Comilla, Narsingdi, Jamalpur, Rajshahi, Sylhet, Faridpur, Rangpur, Bhola, Shariatpur, Khulna, Nilphamari
2012-0175	Flood	24 Jun 2012	139	5,148,475	Chittagong, Cox's Bazar, Bandarban, Sylhet
2012-0382	Flood	21 Sep 2012		250,000	Barisal, Bhola, Patuakhali, Dhaka, Faridpur, Jamalpur, Madaripur, Manikganj, Rajbari, Shariatpur, Tangail, Bogra, Pabna, Sirajganj, Gaibandha, Kurigram
2012-0385	Storm	10 Oct 2012	108	129,558	Noakhali, Bhola, Chittagong
2013-0085	Storm	22 Mar 2013	31	8,543	Brahminbaria
2013-0090	Storm	29 Mar 2013	2	25,020	Nature, Naogaon
2013-0138	Storm	16 May 2013	17	1,498,644	Patuakhali, Bhola, Barguna

Source: All data come from the EM-DAT database (<http://www.emdat.be/database>), an emergency events database collected by the Centre for Research on the Epidemiology of Disasters (CRED).

Table A1.2: List of Natural Disasters in Pakistan, 2010–2013

Disaster No.	Disaster Type	Date Started	Totals Deaths	Total Affected	Affected Regions (Districts)
2010-0053	Flood	8 Feb 2010	22		Batagram, Kohistan, Shangla, Swat (North-West Frontier [NWF] province)
2010-0210	Storm	6 Jun 2010	23	4,000	Karachi, Hyderabad (Sindh), Balochistan
2010-0282	Flood	22 Jun 2010	46		Chitral (NWF province)
2010-0293	Flood	21 Jul 2010	60	4,000	Barkhan (Balochistan)
2010-0341	Flood	28 Jul 2010	1,985	20,359,496	Entire Pakistan
2011-0347	Flood	12 Aug 2011	509	5,400,755	Sindh province
2012-0325	Flood	4 Sep 2012	12		Other province
2012-0363	Flood	Aug 2012	480	5,049,364	Jaffarabad, Jhal Magsi, Nasirabad (Balochistan), DG Khan, Rajanpur (Punjab), Dadu, Ghotki, Jacobabad, Larkana (Sindh)
2012-0475	Flood	23 Aug 2012	26	1,200	NWF province
2013-0068	Flood	3 Feb 2013	34	57	Punjab, other, NWF provinces
2013-0276	Flood	7 Aug 2013	234	1,497,725	Entire Pakistan

Source: All data come from the EM-DAT database (<http://www.emdat.be/database>), an emergency events database collected by the Centre for Research on the Epidemiology of Disasters (CRED).

APPENDIX 2. SUPPLEMENTARY RESULTS

Table A2.1: Changes from Disaster Exposure, Seemingly Unrelated Regression Results

Variable	Bangladesh				Pakistan	
	(1)	(2)	(3)	(4)	(5)	(6)
	Floods		Storms		Flood	
	Farm	Nonfarm	Farm	Nonfarm	Farm	Nonfarm
Flood	0.444*** (0.137)	-0.489*** (0.131)				
Farmer x Flood	-0.420*** (0.140)	0.489*** (0.134)				
Storm			0.748*** (0.268)	-0.519** (0.258)		
Farmer x Storm			-0.723** (0.306)	0.642** (0.294)		
Flood 2012					-2.662** (1.268)	0.479 (1.052)
Flood 2011					2.498* (1.302)	0.448 (1.080)
Age	0.037*** (0.013)	0.011 (0.013)	0.036*** (0.013)	0.013 (0.013)	-0.078 (0.052)	-0.115*** (0.043)
(Age) ²	-0.000*** (0.000)	-0.000 (0.000)	-0.000*** (0.000)	-0.000 (0.000)	0.001* (0.001)	0.001*** (0.000)
Household size	0.117 (0.100)	-0.095 (0.096)	0.110 (0.100)	-0.089 (0.097)	0.334 (0.373)	-0.011 (0.309)
(Household size) ²	-0.015* (0.009)	0.010 (0.008)	-0.015* (0.009)	0.010 (0.008)	-0.023 (0.029)	0.009 (0.024)
Education	0.024 (0.014)	-0.022 (0.014)	0.026* (0.014)	-0.024* (0.014)	-0.027 (0.031)	0.066*** (0.025)
Males	-0.055 (0.040)	-0.151*** (0.038)	-0.051 (0.040)	-0.158*** (0.038)	0.176 (0.134)	0.535*** (0.111)
Females	0.070 (0.048)	-0.033 (0.046)	0.063 (0.048)	-0.031 (0.046)	0.160 (0.149)	-0.001 (0.123)
Tractor	-0.041 (0.073)	0.049 (0.070)	-0.037 (0.073)	0.048 (0.070)	-0.108 (0.390)	-0.385 (0.323)
Irrigation pump	-0.071 (0.108)	0.134 (0.103)	-0.075 (0.108)	0.140 (0.104)	-0.022 (0.322)	-0.241 (0.267)
Other agricultural assets	0.171* (0.097)	-0.017 (0.092)	0.138 (0.097)	0.013 (0.093)	-0.022 (0.304)	0.227 (0.253)
Electricity connection	-0.080 (0.068)	-0.038 (0.065)	-0.093 (0.069)	-0.024 (0.066)	0.598 (0.505)	-0.651 (0.419)
Ln(Farm size)	0.708 (1.181)	-0.203 (1.130)	0.575 (1.179)	-0.002 (1.134)	-7.914*** (2.189)	-6.600*** (1.817)
Credit constraint	0.014 (0.011)	0.012 (0.010)	0.014 (0.011)	0.011 (0.010)	-0.026 (0.042)	-0.001 (0.035)
Constant	-1.450*** (0.438)	-0.002 (0.420)	-1.287*** (0.438)	-0.167 (0.421)	-1.084 (1.732)	1.950 (1.437)
Observations	703	703	703	703	842	842
R ²	0.143	0.139	0.139	0.127	0.193	0.278

Notes: Standard errors in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. We do not report the *thana* or *tehsil* (location) dummies; however, they are available upon request. Sources: All household data come from the Bangladesh Climate Change Adaptation Survey (BCCAS) I and II for Bangladesh and the Pakistan Rural Household Panel Survey (PRHPS) I and II for Pakistan.

Table A2.2: Changes from Disaster Exposure, Results Excluding the Control Variables

Variable	Change in the Dependence on Agriculture			Savings Change			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Bangladesh		Pakistan	Bangladesh		Pakistan	
	Floods	Storms	Flood	Ln(Livestock) Floods	Ln(Livestock) Storms	Ln(Savings)	Ln(Livestock)
Flood	0.137*** (0.035)			-0.432 (0.595)			
Farmer x Flood	-0.172*** (0.041)			0.123 (0.643)			
Storm		0.308*** (0.105)			-0.325 (0.666)		
Farmer x Storm		-0.310** (0.133)			0.297 (0.488)		
Flood 2012			-0.131 (0.146)			-0.444 (0.301)	-0.217 (0.241)
Flood 2011			-0.002 (0.120)			0.053 (0.257)	-0.014 (0.194)
Constant	-0.038*** (0.014)	-0.041*** (0.011)	-0.202*** (0.032)	0.196 (0.169)	0.123 (0.160)	-0.274 (0.273)	0.056 (0.069)
Observations	703	703	849	703	703	849	849
R ²	0.018	0.016	0.010	0.003	0.000	0.004	0.003

Notes: Standard errors in parentheses. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. We do not report the *thana* or *tehsil* (location) dummies; however, they are available upon request.

Sources: All household data come from the Bangladesh Climate Change Adaptation Survey (BCCAS) I and II for Bangladesh and the Pakistan Rural Household Panel Survey (PRHPS) I and II for Pakistan.

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Do Natural Disasters Change Savings and Employment Choices?

Evidence from Bangladesh and Pakistan

Bangladesh and Pakistan are among the countries most vulnerable to livelihood risks arising from frequent exposure to large-scale natural disasters. We study household responses to floods and storms in terms of short-term changes in their dependence on agriculture. Results show that rural households temporarily move away from agriculture in response to disaster then come back after a short period of time. They therefore remain vulnerable to climatic extremes. Development of nonfarm employment opportunities in rural areas can therefore be a useful public policy to lower their dependence on agriculture and reduce their income and livelihood vulnerabilities.

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