WPS6134

Policy Research Working Paper 6134

Rainfall Variability, Occupational Choice, and Welfare in Rural Bangladesh

Sushenjit Bandyopadhyay
Emmanuel Skoufias

The World Bank
Poverty Reduction and Economic Management Network
Poverty Reduction and Equity Unit
July 2012

Policy Research Working Paper 6134

Abstract

This study investigates the choice of occupational focus versus diversification between household members in rural Bangladesh as an autonomous and proactive adaptation strategy against ex ante local rainfall variability risks. The analysis combines nationally representative household level survey data with historical climate variability information at the Upazila level. The authors note that flood prone Upazilas may face reduced risks from local rainfall variability as compared with non-flood prone Upazilas. They find that two members of the same household are less likely to be self-employed in agriculture if they live in an area with high local rainfall variability. However, the occupational diversification strategy comes at a cost to households in terms of consumption welfare. The paper considers the effects of three policy actions, providing access to credit, safety net, and market. Access to market appears to be more effective in reducing the likelihood of costly within-household occupational diversification as an ex ante climate risk-reducing strategy as compared with access to credit and safety net.

This paper is a product of the Poverty Reduction and Equity Unit, Poverty Reduction and Economic Management Network. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at eskoufias@worldbank.org.

Rainfall Variability, Occupational Choice, and Welfare in Rural Bangladesh

Sushenjit Bandyopadhyay and Emmanuel Skoufias

Poverty Reduction and Equity Unit

THE WORLD BANK

JEL classification: Q54, J43, O12

Keywords: Climate variability; Rural occupation; Welfare; Bangladesh

Corresponding author: Emmanuel Skoufias, The World Bank (Mail Stop: MC4-415), 1818 H Street NW, Washington DC 20433-USA. tel: (202) 458-7539. fax: (202) 522-3134. e-mail: eskoufias@worldbank.org.

Acknowledgements: The authors are grateful to Lalita Moorty, Nobuo Yoshida, and Syud Amer Ahmed for constructive comments and suggestions. The authors thank Brian Blankespoor for assistance with GIS and the market index. The findings, interpretations, and conclusions in this paper are entirely those of the authors and they do not necessarily reflect the view of the World Bank

Table of Contents

List of Tables

1. Introduction

The occupational and sectoral choices of the millions of rural households in developing countries are important determinants of economic growth. In the context of traditional growth models where a rural economy is identified with activities solely in the agricultural sector, sectoral diversification is synonymous with rural to urban migration. However, the view that rural economies are purely agricultural has recently been questioned. Reardon et al. (2006) review survey evidence from a large number of developing economies and show that on average rural nonfarm income constitutes about 40 percent of household incomes. In Bangladesh, the share of nonfarm household income grew from 42 percent in 1987 to 54 percent by 2000 (Reardon et al 2006, Hossain, 2004).

Two types of factors, pull and push, induce households to diversify between farm and nonfarm activities. The pull factors include increasing demand, higher wage rates, and higher returns from nonfarm activities. High returns allow households to accumulate capital and invest in farm and nonfarm activities with high returns. This type of diversification requires access to credit, as well as physical, human and social capital and leads to higher growth.

Higher growth could also be achieved by focusing on a single occupation or sector. In this case household members can increase productivity and growth by learning from each other's experience. For example, two members of a household, say a father and his son, jointly decide on which sector to enter in order to maximize household welfare. If the son enters the same sector as the father, he will be able to pick up the necessary skills faster as he learns from his father's experience (Menon and Subramanian, 2008). However, lack of access to credit and capital, and the presence of idiosyncratic and uninsured risks may push rural households away from focusing on a specific sector into diversified activities, thus compromising growth.

In rural areas, one important push factor is year to year variability in rainfall and associated farm-income variability. Households may engage in nonfarm activities with low risks even if they have low returns. In areas with poor agro-climatic conditions, risky agriculture, and no insurance markets, nonfarm activities allow households to cope with severe downturns in agricultural productivity (Reardon et al., 2006; Ellis, 2004). Households pushed to diversify their activities may thus have lower returns and experience lower consumption growth in comparison to households that diversify due to pull factors. At the household level, diversification due to push factors may result in more income security but at the cost of a lower level of welfare and overall growth. [1]

The increased variability in rainfall that is usually associated with climate change[2], implies that the prevailing risk mitigation strategies developed after years of exposure and experience with the prior climate regime may become less and less effective. Thus it is imperative to establish empirically whether

[1] Households may also self-insure against weather risks by "saving for the rainy day." However, savings for self-insurance as opposed to investment in productive capital also hinders growth.

[2] Climate can be thought of as the expected distribution of weather. In this study we will focus on one aspect of climate variability, i. e. rainfall variability at the local and regional level. Rainfall variability is expected to increase in a warming world. Climate change is projected to increase the number of extreme temperature and rainfall events, and hence climate variability is expected to show an upward trend.

auxiliary government interventions can facilitate household adaptation to increased risks due to climatic change faced by households. If access to safety net programs, for example, is associated with a decreased role of push factors in the occupational choice of households participating in these programs, then there is credible evidence that expansion of the coverage of safety net programs is not only likely to protect household welfare but also enhance economic growth.

On the other hand, presence of idiosyncratic and common risks may push rural households from focusing on a specific sector into diversified activities. For example, households face year-to-year variability in local rainfall and associated variability in farm-income.

A Household's experience with the historical rainfall variability allows for coping strategies such as occupational focus or diversification. Households may anticipate and prepare for a certain level of rainfall variability and its effect on their livelihood. For example, local rainfall variability may have idiosyncratic effects on local agricultural production.

Bangladesh is one of the most flood-prone countries in the world (Yu et al, 2010). The country is situated at the confluence of three major rivers – the Ganges, the Brahmaputra, and the Meghna and is intersected by more than 200 minor rivers. There are 54 rivers that enter Bangladesh from India alone. Over 90 percent of the Ganges-Brahmaputra-Meghna basin lies outside the boundaries of the country. Thus, flood in Bangladesh depends on the precipitation outside as well as inside its borders. Regional rainfall variability may have common effects on the probability of river-bank flooding.

Climate change model predict Bangladesh will be warmer and wetter in the future. Yu et al (2010) note that historical rainfall variability is substantial and greater uncertainty exits with the estimated magnitude of rainfall changes than temperature changes. If households base their occupational selections with lower welfare to cope with historical local rainfall variability, then climate change resulting in higher rainfall variability may imply further welfare loss to these households.

We study how rural households cope with historical rainfall variability in order to understand how long term changes in climatic parameters such as increase in local rainfall variability will affect household decisions and welfare. We focus on historical local rainfall variability and historically flood affected areas as measures of ex ante risks faced by rural households. The spotlight on long term historical rainfall variability distinguishes this study from others that look at rainfall and flood shocks and their aftermath. We establish how historical climatic patterns such as long term coefficients of variation in local rainfall and historically flood affected areas affect the choices of rural households' occupational selections.

High regional rain may or may not coincide with high local rainfall. River-bank floods may mask the effects of local rainfall variability in the flood prone areas and households may make occupational choices differently in historically flood prone areas. Separate analysis of historically flood prone and non-flood prone areas show local rainfall variability is a factor in household occupational selections only in non-flood areas.

We also look at the ex post realization of consumption welfare associated with occupational choices that may be determined by the flood and local rainfall variability risks. We investigate whether ex ante flood and local rainfall variability risks reduce consumption welfare through occupational diversification choices. For example, if the households' adaptation strategy of occupational diversification is as productive as occupational focus, then we expect the ex ante flood risk indicator to have no effect on ex post household welfare. Alternately, if households' adaptation of diversification strategy is less productive than the strategy of occupational focus then households living in areas with higher climate variability are expected to have lower consumption welfare. We find that after controlling for other factors, households living in areas with high local rainfall variability have lower consumption.

This study explains how rural households cope with two major ex ante climate risks, flood and local rainfall variability. Further, we examine how effective the households' as well as various policy actions are in mitigating these ex ante climate risks. In addition, it would serve as a useful addendum to the larger climate change-growth analysis being carried out for Bangladesh.

The rest of the paper considers the empirical underpinnings of the basic story outlined above in greater detail. Section 2 highlights the characteristics of Bangladesh and sets the contexts of flood and rainfall variability in the country. Section 3 describes the various datasets used in the analysis. Section 4 focuses on the methods and econometric specifications. Section 5 presents the main findings and results. Section 6 concludes.

2. Background

Bangladesh is widely recognized as one of the most climate vulnerable countries in the world. Climate change is expected to affect the country in many different ways. The Government of Bangladesh recognized the following likely effects of the climate change on the country in its 2009 Climate Change Strategy and Action Plan (MoEF 2009): Heavy and more erratic rainfall on the Ganges-Brahmaputra-Meghna river catchment areas as a whole; lower and more erratic rainfall in northern and western parts of the country; melting of the Himalayan glaciers; increasing and frequent tropical cyclones; and sea level rise.

The Ganges-Brahmaputra-Meghna river catchment areas include parts of the Himalayas and other upstream areas in the neighboring countries. Heavy rainfall in these areas combined with the melting of the Himalayan glaciers, would lead to higher river flows and increased floods in Bangladesh[3]. Flood in Bangladesh is common and considered "normal." In an average year approximately one quarter of the country is inundated (Ahmed and Mirza 2000, MoEF 2009, Yu et al 2010).

Agriculture is a key economic sector in Bangladesh accounting for nearly 20 percent of GDP and 65 percent of the labor force (World Bank 2008, Yu et al 2010). About 70 percent of agricultural GDP is attributed to crop cultivation. The effects of flood on crop cultivation and associated demand for labor depend on the intensity and timing of the flood. For example, flood in May-June or September-October may destroy dry or wet season crops respectively before harvest and thus reduce the wage employment opportunities (Banerjee 2007).

[3] Warmer temperature in the Himalayas would not only melt the glaciers, but also would result in the upstream precipitation in the form of rain instead of snow resulting in more downstream flash floods.

On the other hand, flood in July assist sowing of wet season rice by watering the fields (Islam et al 2004, Quasem 1992). Flood in August may wash away transplanted seedlings and increase the demand for labor when the water recedes and farmers replant their fields (Ahmed et al 2001). The timing of normal flood may increase or depress agricultural labor demand; Banerjee (2007) finds long run wages are higher in the flood prone areas. While normal floods may increase agricultural productivity and wage employment opportunities, heavy flood such as those in 1998, 2004, and 2007 have immediate devastating effects on the households.

It is clear from the discussion above that flood water in the flood prone Upazilas is a substitute for monsoon rain during the planting season. As a result, Households in flood prone Upazilas are not as dependent on rain for their crop cultivation as compared with households in non-flood prone Upazilas.

3. Data

This study combines data from several sources such as Bangladesh Household Income Expenditure Survey of 2010 (HIES 2010), historical rainfall recorded at weather stations, rainfall data generated by Climate Research Unit (CRU) of the University of East Anglia, and flood data from Bangladesh Water Development Board. The HIES 2010 was a nationally representative survey undertaken in the 12 month period between January 2010 and January 2011. The original survey includes both rural and urban areas; however, we focus on 7,840 rural households from 333 Upazilas. Map 1 shows the location of the Upazilas included in the HIES 2010 survey.

The HIES 2010 collected detailed information about the economic activities of each members of the households it surveyed along with other household level information. To get to the sectoral focus and diversification of household members, we focus on the primary economic activity of working age (10-65) members reported for the past 12 months. Where the members reported multiple economic activities, the highest total man-hour for the economic activity was used to arrive at the primary economic activity of the individual. We compare the economic activities of non-head members with that of the head of the household and construct a set of sectoral focus indicators for each working non-head members.

Low women's participation in economic activities in Bangladesh, by international standards, as reported in household surveys requires some explanation. Some of the low participation is likely due to a range of factors from tradition to low bargaining power of women in the household and society (World Bank 2008). A part of low participation in economic activities may also be explained by low reporting of unpaid family work done by women in the survey. A recent survey seasonal economic activities in the *monga* region as well as a national Labor Force Survey (LFS) suggest women's participation in livestock rearing and other agricultural activities may be under reported in the current and previous HIES surveys (World Bank 2008, Mahadevan et al. 2012).

Table 1 shows the list of key variables and their descriptive statistics. The first set of variables are sectoral focus indicator for non-head members. The second set of variables include monthly per capita household consumption, access to credit and safety-net. The final set of variables are at the Upazila level: access to market, monsoon coefficient of variations, and historically flooded Upazilas.

Table 1: Key variables with descriptive statistics

Description Mean (Standard Errors)	Overall	Non Flood-prone	Flood-prone
Occupational Focus of Members Relative to the Head			
"Same Occupation as Head" takes the value 1 if the member's occupation matches that of the head of the household and 0 otherwise. Detailed occupational classification in the survey was used to define occupation matches.	0.35 (0.008)	0.39 (0.011)	0.30 (0.011)
"Same sector as Head" takes the value 1 if the member's sector matches that of the head of the household and 0 otherwise. Six sectors are defined as, agriculture, construction, transport and public utilities, manufacturing, trade and business, services, and others.	0.39 (0.008)	0.43 (0.011)	0.35 (0.011)
"Both in agriculture" takes the value 1 if both the member and the head of the household report to be engaged in agriculture and 0 otherwise.	0.33 (0.009)	0.36 (0.012)	0.29 (0.013)
"Both self employed" takes the value 1 if both the member and the head of the household report to be self employed and 0 otherwise.	0.55 (0.013)	0.57 (0.017)	0.54 (0.018)
"Both in the same sector and self employed" takes the value 1 if both the member and the head of the household report to be self employed in the same sector and 0 otherwise.	0.17 (0.006)	0.18 (0.009)	0.16 (0.009)
"Both self employed in agriculture" takes the value 1 if both the member and the head of the household report to be self employed in agriculture and 0 otherwise.	0.13 (0.006)	0.14 (0.008)	0.11 (0.007)
Household Characteristics			
Monthly per capita Consumption in Taka	2,175 (17.09)	2,173 (23.81)	2,176 (24.55)
"Access to credit" takes the value 1 if household has taken any loan in past 12 months and 0 otherwise	0.35 (0.005)	0.37 (0.008)	0.34 (0.008)
"access to Safety-net" takes the value 1 if any member of the household availed of safety-net programs in last 12 months and 0 otherwise	0.30 (0.005)	0.32 (0.007)	0.29 (0.008)
Upazila Characteristics			
Access to market index	0.38 (0.014)	0.40 (0.018)	0.36 (0.021)
Monsoon Coefficient of Variation (Based on Stations)	0.21 (0.002)	0.22 (0.002)	0.21 (0.002)
Monsoon Coefficient of Variation (Based on CRU 3.1)	0.18 (0.002)	0.18 (0.002)	0.18 (0.002)
"Flood prone Upazilas" are historically Flooded Upazilas of 1998	0.51 (0.027)		

Full list of variables is in the annex Table A1

Household per capita monthly consumption expenditure measure is derived from the HIES 2010 survey as part of the poverty assessment. The consumption expenditure is deflated by rural Dhaka Division prices to account for regional price variations. We control for seasonal differences in consumption expenditure with three seasonal indicators; winter takes the value 1 for households surveyed in

December-February, monsoon takes the value 1 for June-September, and autumn takes the value 1 for October-November, and 0 otherwise.

Access to credit is identified with the loan indicator variable that takes the value 1 if the household had taken any loans in the last 12 months from family, friends, micro-finance institutions, banks, or other sources. The safety net indicator variable takes the value 1 if at least one member of the household benefited from one of the safety net programs (See Table A2 in annex tables) and 0 otherwise.

The access to market index measures how easily people can reach markets; it is the sum of the population of the markets in the vicinity of a location inversely weighted by the travel time along the transportation network to these markets (Blankespoor and Yoshida, 2010). The index was calculated with the negative exponential potential accessibility model for 202 markets with populations ranging from approximately 15,000 to 6,500,000 (Dhaka) and aggregated at the Upazila level. The access to market index is a continuous variable that takes values between 0 and 1. Map 2 shows the access to market index for various Upazilas in Bangladesh. The construction of local rainfall variability, and historically flood prone areas are described in detail below.

We control for other factors such as household age-group composition with three variables, number of females in the household ten years or older, number of males in the household ten years or older, and number of dependents. We include the number of household members between 10 and 65 engaged in agriculture in some of the specifications. Household level education is measured by the share of literates in the household (See Table A1 for a complete list of variables and their descriptive statistics).

We use a household wealth proxy with land ownership and livestock indicator variables. Land ownership takes the value 1 if the household owns more than the average land in the survey and 0 otherwise. The average land is the mean of land owned by the households that own land. Livestock indicator takes the value 1 if the household owns any livestock and 0 otherwise. Access to electricity and cell or land-line phones are used as measures of a proxy for access to infrastructure and communication. The Upazila population is expected to proxy for economic development.

Rainfall variability

We considered two sources of rainfall data. First, historical monthly rainfall data from 1948 to 2010 was from the Meteorological Department of Bangladesh for 35 weather stations around the country. The weather station data represents actual measured rainfall at the specific station and time and thus, are more accurate. On the other hand, substantial manipulation is needed to estimate rainfall at each Upazila from the weather station data. We used inverse distance weighted average of three nearest stations to estimate the rainfall for each Upazila for each month. However, this method does not control for altitude and other geographical characteristics and Upazilas near international boundaries do not take weather stations in other countries that may be closer than those in Bangladesh into account.

The second source of rainfall data is from the Climate Research Unit of the University of East Anglia. Estimated monthly rainfall for most of the world is available by the half degree resolution from 1902 to 2009. The CRU estimation combines weather station data with other information to arrive at the estimates. Previous versions of the CRU data were homogenized to reduce variability and provide more accurate estimation of mean rain at the cost of variability estimation. The version 3.1 data is not homogenized and thus allows for better variability estimates. The estimates of rainfall near international boundaries are not less reliable as compared with those in the interior of the country, as the CRU estimation utilizes data from all the weather stations in the region.

To arrive at the Upazila level rainfall estimates from the CRU data, we use area weighted averages. For example if an Upazila covers two half degree grid cells for which CRU has rainfall estimates. We use the average rainfall of the two grid-cells, where the weights are the proportion of the area of the Upazila in each grid-cell. Map 3 shows the locations of rainfall stations in Bangladesh in relation with the Upazilas and compares it with the 0.5 degree of the CRU rainfall data.

We use coefficient of variation as the measure of local rainfall variability.[4] Total rainfall for the monsoon season of June-September is calculated for each year for the 30 year period 1980-2009 for each Upazila. The long term historical local variability is then calculated as the coefficient of variation in total monsoon rain for this 30 year period. Map 4 shows the spatial rainfall variability by Upazilas based on the CRU data.

Bangladesh Water Development Board characterizes the 1998 flood as:

> The 1998 flood in Bangladesh has been characterized as one of the catastrophic deluge on record. River water levels exceeded danger levels for country's all of the major rivers. It was combined with local rainfall in catchment areas of small rivers. All these influences including overbank flow and drainage congestion resulted in a flood that extended over most of the country with duration of weeks to months.

Thus, the 1998 flood indicator identifies historically flood prone areas for the whole nation. We identify an Upazila to be historically flood prone if 50% or more of the area in the Upazila were flooded during any of the three periods of August 26, September 10, and September 17 of 1998 for which the percent of Upazila flooded information is available. By this measure about 51 percent of the 333 Upazilas in the survey are historically flood prone. Historically flood prone and non-flood prone Upazilas are identified in Map 5. The map shows that the flood prone Upazilas are concentrated around the Ganges-Brahmaputra-Meghna river-basins.

4. Methodology

Occupational focus

We consider two types of occupational choices made by household members. First, a member may choose between the economic sector to work in such as agriculture, construction, transport and public utilities, manufacturing, trade and business, services, and others. The household member may also decide on the type of employment, and choose between wage and self employment. Sectoral diversification may be ideal when the risks are sector specific, such as flood and rainfall variability may affect agricultural and non-agricultural sectors differently. However, opportunities, access to human,

[4] Coefficient of variation is the ratio of standard deviation and mean. We also tried the mean and standard deviation as two separate indicators of rainfall parameters, and they provide similar results and are not reported.

physical and social capital may limit the choices of sectoral diversification. Within the same sector diversification by employment type may not help mitigate all the risks associated with that sector. However, diversifying between wage and self employment may reduce some of the entrepreneurial risks of self employment.

For example, self employment in agriculture implies bearing higher risks and higher expected returns. On the other hand wage employment may imply lower returns with lower risks. Diversification in employment types within the same sector such as agriculture allows better utilization of generational knowledge of the sector while reducing ex ante risks. For example, unusually high rainfall in the sowing and transplanting time for rice cultivation may require redoing some of these activities thus increasing demand for wage labor. Thus, while the labor cost for the self employed farmer increases, the opportunity and income of members in wage employed agriculture goes up.

We hypothesize that occupational choices of working members other than the head of the household (referred to as 'non-heads' from now on) are based on pull and push factors. As noted above two of the main sources of push factors in rural Bangladesh are floods and local variability of rainfall. That is, in historically flood prone Upazilas we expect more non-head members of households to choose occupations unrelated to agriculture. Or more generally, the head of the household and the non-head members will choose occupations in different sectors. Similarly, in Upazilas where variance of rainfall is high the head and non-head members of the household may diversify between sectors, self and wage employment.

We take into account the pull factor of occupational diversification by controlling for access to human and physical capital and infrastructure, such as education, ownership of land, and access to electricity, and phones. These factors help households to be "pulled into" high return occupationally diversified portfolio.

We test our estimation models with different indicators of within-household occupational and employment homogeneity, such as whether a non-head member chooses occupation in the same sector as the head of the household or if the head member and the non-head members are both in agricultural sector. The different indicators of within-household occupational and employment homogeneity are discussed in greater detail in the data section.

Thus, the indicator of within-household occupational and employment homogeneity is modeled using the following logit specification:

$$\ln\left(\frac{P_{iju}}{1-P_{iju}}\right) = \alpha + \alpha_1 X_{1\,iju} + \alpha_2 X_{2\,ju} + \alpha_3 X_{3\,u} + \alpha_4 FLOOD_u + \alpha_5 RV_u + \varepsilon_{iju} \tag{1}$$

where P_{iju} is the probability that non-head member *i* in household *j* in Upazila *u* has the same occupation or employment characteristics as the household head. $X_{1\,iju}$, $X_{2\,ju}$, and $X_{3\,u}$ are exogenous variables specific to member *i*, household *j* and Upazila *u* respectively. These variables include individual characteristics, like age and gender, household characteristics like land ownership, and education of the head, and Upazila characteristics, like population.

$FLOOD_u$ is the *ex ante* risks of flood measured by flood prone Upazila indicator variable for Upazila *u* and RV_u is the *ex ante* climate risk measure, such as coefficient of variation or standard deviation of annual monsoon rain over the last 30 years in the Upazila *u*. The hypothesis that increased ex ante climate risks such as flood or greater variability of local rain will lead to smaller probabilities of non-head members having the same occupational characteristics as the head of the household is true if α_4 or α_5 are negative and significantly different from zero.

Regular floods have traditionally been beneficial in Bangladesh (Yu et al 2010). However, high magnitude floods can have adverse effects on the rural households in the area. Historically flood prone Upazilas may benefit from normal floods and have negative effects from high level floods. One of the beneficial effects of normal flood is less dependence on local rainfall. Thus, agricultural activities in historically flood prone Upazilas may not face the same local rainfall variability risks as compared with non-flood prone Upazilas. To test this hypothesis we estimate the occupational choice models separately for the historically flood prone Upazilas and non-flood prone Upazilas.

If households consider high river-bank floods from regional rainfall variability to be the more important risk as compared with the local rainfall variability, then we expect local rainfall variability in historically flood prone Upazilas to have no effects on the occupational focus or diversity within household. On the other hand, in Upazilas those are not historically flood prone, and thus do not benefit from normal floods, or adversely affected by high floods we expect households to be sensitive to local rainfall variability in their occupational choices.

Policy actions by the government and the NGOs cannot directly reduce the climate risks. However, extra resources made available through policy actions may help households mitigate the ex ante climate risks without occupational diversification that may lower household welfare. We consider three factors that can be altered by policy action, access to credit, access to social safety-net, and access to market.

If households have access to credit then diversification in occupational and employment choices in order to insure welfare against ex ante climate risks may be less urgent as compared with no access to credit. Similarly access to social safety-net may act as an insurance against ex ante climate risks. Finally access to market may make new resources available to households allowing better protection against ex ante climate risks.

In order to analyze how the access to resources made available through policy actions mediate the effects of ex ante rainfall variability risks on household welfare we use a variant of equation (1):

$$\ln\left(\frac{P_{iju}}{1-P_{iju}}\right) = b + b_1 X_{1\,iju} + b_2 X_{2\,ju} + b_3 X_{3\,u} + b_4 RV_u + b_5 PA_{ju\,/\,u} + b_6 (RV_u \times PA_{ju\,/\,u}) + e_{iju} \quad (2)$$

Where $PA_{ju/u}$ is one of the three policy action variables for the household I in Upazila u. Note, access to credit and safety-net is at household level while access to market is at Upazila level. Equation (2) highlights the interaction term between RV_u and $PA_{ju/u}$.

The effects of rainfall variability risks on occupational choice that are not influenced by policy action variables are captured by the b_4 and as before we expect b_4 to be negative. For households influenced by policy actions, such that they have access to credit, safety-net, or market, the additional effects of rainfall variability risks are captured by b_6. Since we expect the policy actions to reduce the negative effects of rainfall variability risks on household welfare, we expect b_6 to be positive. The net effect of rainfall variability and policy action on household occupational choices is then measured by ($b_4 + b_6$). If ($b_4 + b_6$) is not significantly different from zero, then the policy action is effective in completely mitigating the effects of the rainfall variability risks on occupational choices.

Welfare effects of climate variability

We believe if households diversify their occupational and employment portfolio to cope with flood or local rainfall variability then they may have no option but to choose occupations and employment with lower productivity and income. Since we cannot directly measure household members' productivity, we focus on per capita consumption expenditure as a measure of household welfare. If household members accept less productive occupations to cope with local rainfall variability, then we expect households living in high rainfall variability Upazilas to have lower per capita consumption welfare.

We examine how rural household welfare, measured by per capita consumption expenditure, is affected by flood and local rainfall variability. We test the hypothesis that households are unable to completely mitigate the negative effects of flood or local rainfall variability risks. Where the negative effects of local rainfall variability are significant on household welfare, we further test the hypotheses that policy variables such as access to credit, and safety-net are effective means of reducing the negative welfare effects of local rainfall variability.

To test the hypothesis ex ante climate risks such as flood-prone areas, and higher local rainfall variability has negative effects on consumption welfare of the households, we estimate reduced form models of per capita consumption expenditure as a function of household, and Upazila characteristics as well as ex ante climate risks:

$$\mathrm{lnC_{ju}} = \gamma + \gamma_2 \mathrm{X_{2\,ju}} + \gamma_3 \mathrm{X_{3\,u}} + \gamma_4 \mathrm{FLOOD_u} + \gamma_5 \mathrm{RV_u} + \mathrm{e_{ju}} \qquad (3)$$

where C_{ju} is the per capita consumption expenditure of the household *j* in Upazila *u.* The effects of flood on consumption may either be positive or negative. If the benefits of normal flood is greater on average than the costs of coping with flood risks, then γ_4 will be positive. On the other hand households' choice of diversity in occupation and other coping strategies may have a negative effect on consumption making γ_4 negative.

We anticipate γ_5, the coefficient of local rainfall variability to be negative for two possible reasons. First, if households cope with rainfall variability with low return but diverse occupations, we expect consumption to be low. Second, households may also self insure themselves by reducing consumption and increasing savings. Low risk low return occupations as well as self insurance with higher liquid assets both result in lower capital accumulation at the household level.

We test the hypothesis that occupational choice is a significant pathway by which local rainfall variability negatively affects consumption welfare. To this end, we estimate consumption as a function of household occupational focus and other factors, where the occupational focus variable is treated as endogenous and is instrumented by the local rainfall variability measure. Thus, our strategy is to estimate the instrumental variable model as follows:

$$\mathrm{lnC_{ju}} \;=\; \gamma + \gamma_2 \mathrm{X_{2\,ju}} + \gamma_3 \mathrm{X_{3\,u}} + \gamma_4 \widehat{\mathrm{OCCU}}_{\mathrm{ju}} + \mathrm{e_{ju}} \qquad (4)$$

$$\mathrm{OCCU_{ju}} \;=\; \theta + \theta_2 \mathrm{X_{2\,ju}} + \theta_3 \mathrm{X_{3\,u}} + \theta_4 \mathrm{RV_u} + \epsilon_{\mathrm{ju}} \qquad (5)$$

where $\mathrm{OCCU_{ju}}$ takes the value 1 if the head another member in household *j* in Upazila *u* has the same occupation or employment characteristics. We test for the endogeneity of $\mathrm{OCCU_{ju.}}$ Under the null H_0 $\mathrm{OCCU_{ju}}$ is treated to be exogenous. If the negative effect of local rainfall variability on consumption is through the occupational choices of the households, we expect the null to be rejected. We also test the null that $\mathrm{RV_u}$is a weak instrument for $\mathrm{OCCU_{ju}}$ using Anderson-Rubin Wald test test for weak instruments.

In order to analyze how the access to resources made available through policy actions mediate the effects of ex ante rainfall variability risks on household welfare we use a variant of equation (3):

$$\begin{aligned} \mathrm{lnC_{ju}} \;&= \delta + \delta_2 \mathrm{X_{2\,ju}} + \delta_3 \mathrm{X_{3\,u}} + \delta_4 \mathrm{RV_u} + \delta_5 \mathrm{PA_{ju\,/\,u}} + \\ &+ \delta_6 (\mathrm{RV_u} \times \mathrm{PA_{ju\,/\,u}}) + \mathrm{u_{ju}} \end{aligned} \qquad (6)$$

where $PA_{ju\,/\,u}$ is either access to credit, access to safety-net for household *j* in Upazila *u*, or access to market in Upazila *u*. The effects of ex ante rainfall variability risks on household welfare that are not influenced by policy actions are captured by the δ_4 and we expect δ_4 to be negative. For households influenced by policy actions, such that they have access to credit, safety-net, or market, the additional effects of ex ante rainfall variability risks are captured by δ_6. Since we expect the policy actions to reduce the negative effects of ex ante rainfall variability risks on household welfare, we expect δ_6 to be positive. The net effect of ex ante climate risks and policy action on household welfare is then measured by (δ_4 + δ_6). If (δ_4 + δ_6) is not significantly different from zero, then the policy action is effective in completely mitigating the effects of the ex ante rainfall variability risks on household welfare.

To understand the relationship between consumption welfare, policy actions and, in the flood prone Upazilas and non-flood prone Upazilas, we also estimate the equations (1)-(4) separately for the flood prone and non-flood prone sub-samples where we exclude the $FLOOD_u$ indicator variable from the models.

Partitioning the sample into flood prone and non-flood prone Upazilas may give rise to selection bias as floods and rainfall variability may be correlated. We note in Table 1, average rainfall variability in the non-flood prone Upazilas is very similar to that in the flood prone Upazilas. The various control variables at the individual, household, and Upazila levels further reduce selection bias concerns from unobservable factors that may influence individual occupational choices and household consumption expenditure.

We expect normal floods to substitute for rainfall in meeting cropping needs in the flood prone Upazilas. Thus, households in the flood prone Upazilas face lower risks from local rainfall variability. Therefore, we expects the effects of local rainfall variability to be stronger in the non-flood prone Upazilas and weaker and possibly unmeasurable in the flood prone Upazilas.

5. Results

First, we estimate models of various measures of occupational focus and employment types on the pooled sample of historically flood prone Upazilas and non-flood prone Upazilas. Pooling of these two sub-samples allows us to determine how households in flood prone Upazilas differ in terms of their occupational focus as compared with those in non-flood prone Upazilas.

Second, we estimate the models of occupational focus separately on flood prone and non-flood prone Upazilas and test the hypotheses that local rainfall variability have and household occupational focus relationships are different in the non-flood prone Upazilas as compared with its flood prone counterparts.

Finally, we test the hypotheses regarding how historically flood prone Upazilas and local rainfall variability affects household consumption. The models are estimated for the pooled sample as well as separately for historically flood prone and non-flood prone Upazilas. We also test the hypotheses that policy related variables such as access to credit, safety net, and market lowers the ex ante risks of households living in historically flood prone areas, or local rainfall variability.

Climate risks and occupational focus

The main results of estimation of equation (1) for the pooled sample of flood prone and non-flood prone Upazilas are in Table 2. The full model includes the following member characteristics: age of the non-head member, indicators that the member is female, literate, and married. The model also include the household characteristics: the numbers of 10 plus years females and males in the household, the number of dependents, the indicators that the age of the head is more than 65 years, the head has at least primary education, the head is female, the household owns more land than the sample mean, the household has access to electricity, and phone services as well as the Upazila level population. These variables have expected signs where significant and we do not report their coefficients in the body of the paper to conserve space.[5]

[5] The reported models do not include regional fixed effect dummies, as flood and local rainfall variability are somewhat spatially correlated with regional dummies and the effects of these variables of our interests are absorbed into regional fixed effects.

We find households cope with flood and local rainfall variability in different ways. For example, non-head working members and the heads of a household are less likely to be in the same occupation, in the same sector, or both in agriculture if the household lives in the flood prone Upazila (Table 2 Part A). This means households are likely to use sectoral diversification to cope with flood risks. On the other hand, households more likely to diversify between self and wage employment to cope with local rainfall variability.

Part B shows alternate results of the same set of estimations using weather station interpolated measures of local rainfall variability. We find that weather station interpolated measures are not always statistically significant. This may be due to the less sophisticated interpolation methods used in our station based measure of local rainfall variability as compared with the data from CRU. Thus we focus on the results from the CRU data in the rest of the paper.

One possible reason for the insignificant relationships between occupational focus and local rainfall variability may be because “normal” flood may reduce the dependency on local rainfall in crop cultivation. Thus, households living in flood prone Upazilas may use normal flood water as a substitute for rain and irrigation water. If this is correct, households in flood prone Upazilas would face different sets of risks as compared with the households in non-flood prone Upazilas.

To test this hypothesis we estimate separate models for non-flood prone Upazilas and flood prone Upazilas. As expected, we find households in non-flood prone Upazilas use sectoral diversify as well as self versus wage employment to cope with local rainfall variability (Table 2 Part C). On the other hand, since “normal” flood insulates households from local rainfall variability risks in flood prone Upazilas, households there do not need to use sectoral or employment diversity to cope with local rainfall variability (Table 2 Part D).

The results presented in Table 2 indicate that availability of water from “normal” flood where present may reduce the ex ante risks from local rainfall variability. Thus, households use sectoral diversification to avoid flood risks in historically flood prone Upazilas. In the non-flood prone Upazilas both occupational and employment type diversification take place within households to avoid the risks stemming from local rainfall variability.

Table 2: Occupational focus and flood and local rainfall variability, summary results

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
A. Pooled sample, CRU based CV of Rain						
Flooded Upazilas 1998	**-0.331*** **	**-0.263** **	**-0.273***	0.0717	-0.0252	-0.180
	(-3.028)	(-2.455)	(-1.833)	(0.485)	(-0.178)	(-1.049)
CV Rain CRU	-1.439	-1.237	1.076	**-8.948*** **	**-6.434*** **	**-6.330** **
	(-0.695)	(-0.601)	(0.376)	(-3.133)	(-2.602)	(-2.322)
Observations	3709	3709	2792	1153	3709	3709
B. Pooled sample, Station based CV of Rain						
Flooded Upazilas 1998	**-0.350*** **	**-0.272** **	**-0.328** **	-0.0437	-0.100	-0.250
	(-3.055)	(-2.470)	(-2.068)	(-0.278)	(-0.652)	(-1.323)
CV Rain Station Interpolated	-0.831	-0.123	-4.199	**-5.532** **	-2.222	-1.789
	(-0.448)	(-0.0668)	(-1.472)	(-2.021)	(-0.874)	(-0.609)

	(1)	(2)	(3)	(4)	(5)	(6)
Observations	3709	3709	2792	1153	3709	3709
C. Upazilas not flooded in 1998, CRU based CV of Rain						
CV Rain CRU	**-4.365***	**-4.569***	**-4.906***	**-12.06*****	**-9.030*****	**-11.87*****
	(-1.739)	(-1.818)	(-1.669)	(-3.468)	(-2.648)	(-3.209)
Observations	1929	1929	1532	815	1929	1929
D. Upazilas flooded in 1998, CRU based CV of Rain						
CV Rain CRU	4.733	4.906	**12.25*****	-3.293	-1.062	3.710
	(1.486)	(1.511)	(2.683)	(-0.754)	(-0.332)	(1.064)
Observations	1780	1780	1260	738	1780	1780

Robust z-statistics in parentheses based on PSU level clusters *** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variables for each column are (1) "Same Occupation as Head," (2) "Same Sector as Head," (3) "Both in Agriculture", (4) "Both self-employed," (5) "Both in the same sector and self employed," and (6) "Both self employed in agriculture" respectively. Full estimation results are in the annex Table A3, Table A4, Table A5, and Table A6.

Policy interactions

The three policy action variables, access to credit, safety net, and market are expected to reduce occupational choice constraints. That is, if households have access to credit, safety net, or market, households may cope with floods or local rainfall variability without resorting to diversifying to those occupations with lower but less risky income. We expect the coefficients of these indicators to be negative and find that to be true where significant.

To test the hypotheses that policy action variables, access to credit, safety-net, and market may help mitigate the effects of flood and rainfall variability risks on occupational choices, we estimate the equation (2) for the households in the non-flood prone Upazilas. Table 3 presents the relevant coefficients, their interactions, and the test of the sum to be 0 for the selected equation (2).

Access to credit and safety net have some dampening effects on some of the measures of sectoral and employment diversity attributable to flood and local rainfall variability risks. For example, in the flood prone Upazilas members of the households with access to credit or safety net are more likely to be in the same occupation as compared with households in flood prone Upazilas with no access to credit or safety net (Table 3, columns 1 and 2). Thus, access to credit or safety net is helpful to some extent to the households in the flood prone Upazilas in reducing the need to diversify into different occupation.

On the other hand, access to market may completely obliterate the households' need to diversify into different occupations if they live in flood prone Upazilas (Table 3, column 3). The interaction between access to market and flood prone Upazilas is positive and significant and almost as big in magnitude as the coefficient of the flood prone Upazila by itself. This implies the strong positive effects of the interaction between market and flood completely cancels out the negative effects of flood on need to diversify into different occupations.

The effects of the policy action variables are similar when we consider local rainfall variability in the non-flood prone Upazilas. We have already established that local rainfall variability is only important to the households who live non-flood prone Upazilas. Thus, the analysis of policy interaction with local rainfall variability is only relevant for households in non-flood prone Upazilas.

For example, in the Upazilas with high local rainfall variability, members of the households with access to credit or safety net are more likely to be self employed in agriculture as compared with households in Upazilas with high local rainfall variability and no access to credit or safety net (Table 3, columns 16 and 17). However, the coefficients of the interaction between local rainfall variability and access to credit and safety net are small as compared with the coefficients of local rainfall variability by itself. Thus, access to credit and safety net is unable to completely negate the need diversify from self employed agriculture to other economic activities when households are faced with higher local rainfall variability.

As with the flood risk, access to market may completely obliterate the households' need to diversify from self employment in agriculture if they live in Upazilas with high local rainfall variability (Table 3, column 18). Thus we find that access to market may prevent households to be pushed to occupational and employment diversification while access to credit or safety net does not completely prevent such push from flood and local rainfall variability.

These results are not robust to the choices of different occupational focus indicators used in the left hand side of the equations. In some of these cases the interaction coefficients have the unexpected negative sign. In others we do not get the differentiated results between access to credit or safety net in one hand and access to market in the other. These results suggest access to credit or safety net may have similar effect on sectoral or employment focus of households as access to market. These results are presented in Table 3, columns 4 through 15.

Table 3: Interaction between flood or local rainfall variability and policy action variables.

	Interaction with Flood prone Upazilas					
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variables	Both in the same occupation			Both the same sector		
Policy interaction term:	Credit	Safety Net	Market	Credit	Safety Net	Market
Flood prone Upazilas (b_4)	**-0.353*****	**-0.372*****	**-0.623*****	**-0.318****	**-0.322*****	**-0.450****
	(-2.702)	(-2.906)	(-3.419)	(-2.461)	(-2.581)	(-2.406)
Policy X Flood (b_6)	0.0505	0.105	**0.729***	0.129	0.151	0.472
	(0.280)	(0.562)	(1.717)	(0.768)	(0.828)	(1.047)
Test $b_4+b_6 = 0$	**-0.303****	**-0.267***	0.107	-0.189	-0.170	0.0223
χ^2 (1)	3.879	2.746	0.127	1.745	1.158	0.00494
χ2 > Prob	0.0489	0.0975	0.721	0.187	0.282	0.944
Observations	3709	3709	3709	3709	3709	3709

	Local rainfall variability in non-flood prone Upazilas					
	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variables	Both in th same sector			Both self employed		
Policy interaction term:	Credit	Safety Net	Market	Credit	Safety Net	Market
CV Rain CRU (b_4)	**-5.404***	**-5.537****	-3.787	**-11.90*****	**-16.57*****	-7.575
	(-1.898)	(-2.058)	(-0.794)	(-2.712)	(-3.703)	(-0.981)
Policy X CV Rain CRU (b_6)	2.286	1.709	-2.062	-0.938	**12.83****	-16.26

	(0.569)	(0.508)	(-0.145)	(-0.135)	(2.130)	(-0.701)
Test $b_4+b_6 = 0$	-3.118	-3.828	-5.849	**-12.84****	-3.737	-23.83
χ^2 (1)	0.736	1.289	0.314	5.231	0.615	2.051
χ2 > Prob	0.391	0.256	0.575	0.0222	0.433	0.152
Observations	1,929	1,929	1,929	815	815	815

Local rainfall variability in non-flood prone Upazilas (Continued)

	(13)	(14)	(15)	(16)	(17)	(18)
Dependent variables	Both self employed in the same sector			Both self employed in agriculture		
Policy interaction term:	Credit	Safety Net	Market	Credit	Safety Net	Market
CV Rain CRU (b_4)	**-11.19****	**-10.10****	**-15.20****	**-12.37****	**-12.22*****	**-14.79***
	(-2.436)	(-2.411)	(-2.225)	(-2.411)	(-2.678)	(-1.887)
Credit X CV Rain CRU (b_6)	4.837	1.947	23.05	1.144	0.521	11.79
	(0.786)	(0.397)	(1.082)	(0.163)	(0.0947)	(0.492)
Test $b_4+b_6 = 0$	-6.350	**-8.150***	7.853	**-11.22****	**-11.70****	-2.998
χ^2 (1)	1.928	3.685	0.249	5.391	6.305	0.0297
χ2 > Prob	0.165	0.0549	0.618	0.0202	0.0120	0.863
Observations	1,929	1,929	1,929	1,929	1,929	1,929

Robust z-statistics in parentheses based on PSU level clusters *** p<0.01, ** p<0.05, * p<0.1. Full estimation results are in annex Table A7, and Table A8

Welfare effects

So far we have seen that flood prone Upazilas, and local rainfall variability pushes households to diversify their occupational choices. We have also seen that policy action variables like access to credit, safety net, and market may reduce or eliminate the need to diversify that stems from either living in flood prone Upazilas, or living in Upazilas with high rainfall variability.

To test the hypotheses that household members accept less productive occupations to cope with local rainfall variability, or flood, we focus on per capita consumption. We expect households living in high rainfall variability Upazilas to have lower per capita consumption welfare.

A similar argument can be made about flood risks and low productivity leading to low consumption. However, others have shown that "normal" flood may increase productivity and wage rates (Islam et al 2004, Quasem 1992, Banerjee 2007). Thus, productivity loss from diversification may be partly or fully compensated by the productivity gains from "normal" flood.

The key results of equations (3) are presented in Table 4. Columns 1, 2, and 3 of Table 4 show the estimation coefficients for the household consumption equation (3) for the pooled sample and for historically non-flood prone, and flood prone Upazilas respectively. In the pooled sample (column 1) the coefficient of the flood prone indicator variable has the right sign but is not statistically significant. That is, households living in historically flood prone Upazilas do not appear to have lower (or higher) consumption as compared with those in non-flood prone Upazilas after controlling for other factors.

The insignificant coefficient of the flood prone indicator may be explained by two reasons. First, the beneficial effects of low level floods may compensate the risks of high flood risks to some extent. Second, the ability to diversify occupational choices within household in the historically flood prone Upazilas as evidenced in Table 2 may allow households to better protect their consumption welfare.

Table 4: Effects of flood and local rainfall variability on consumption welfare

	(1)	(2)	(3)
Sample:	Overall	Non-flood	Flood
Flooded Upazilas 1998	0.0141		
	(0.734)		
CV Rain CRU (β_4)	**-1.109*** **	**-1.642*** **	-0.432
	(-2.891)	(-4.020)	(-0.625)
Observations	7,697	3,886	3,811

Robust t-statistics in parentheses based on PSU level clusters. *** p<0.01, ** p<0.05, * p<0.1. Full estimation results are in annex Table A9.

The effects of local rainfall variability on consumption welfare is negative and significant in the pooled sample (Column 1) as well as in non-flood prone Upazilas (Column 2) and in flood prone Upazilas (Column 3). Thus households in Upazilas with higher rainfall variability have lower consumption after controlling for other factors. Beneficial effects of low level floods may compensate for some of the local rainfall variability as the size of the coefficient of local rainfall variability for flood prone Upazilas (Column 3) is 22 percent smaller than that for the non-flood prone Upazilas (column 2).

To test the structural hypotheses that local rainfall variability affects welfare through occupational choices we estimate the IV equations (4) and (5) for non-flood prone Upazilas. Table 5 shows the second stage coefficients of equation (5) for three measures of occupational focus: (1) the head and at least one member of the household are self employed, (2) the head and at least one member of the household are self employed in the same sector, and (3) the head and at least one member of the household are self employed in agriculture. As before the dependent variable is log of per capita monthly consumption.

Table 5: Effects of occupational focus on household welfare in non-flood prone Upazilas

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	OLS	IV	OLS	IV	OLS	IV
Both self employed	**0.102*** **	**1.160***				
	(2.844)	(1.876)				
Both self employed in the same sector			**0.109*** **	**1.530** **		
			(3.817)	(2.422)		
Both self employed in agriculture					**0.122*** **	**1.414*** **
					(3.692)	(2.917)
Observations	591	591	1,425	1,425	1,425	1,425
Endogeneity Test χ^2 (1)		**6.087** **		**9.409*** **		**9.199*** **
Anderson-Rubin weak Instrument Test χ^2 (1)		**7.75*** **		**11.64*** **		**11.64*** **

Robust t-statistics in parentheses based on PSU level clusters, *** p<0.01, ** p<0.05, * p<0.1 . Full estimation results are in annex Table A10

We find that occupational focus within household increase welfare. In all cases the OLS estimates (columns 1, 3, and 5) are smaller than the IV estimates (columns 2, 4, and 6). This is consistent with our earlier results and the hypothesis that the OLS estimates capture both the direct positive effect of occupational focus as well as the indirect negative effects of local rainfall variability on consumption. The null that the occupational focus variables are exogenous is rejected for all the 3 measures of occupational focus at 5 percent level of significance or better. The Anderson-Rubin Wald test for weak instruments rejects the null at 1 percent level or better for all three measures of occupational focus. Thus, the IV estimations confirm our hypothesis that the household adaptation to higher local rainfall variability by occupational diversification comes at a cost of welfare loss.

The estimates of the consumption models with the interactions terms between local rainfall variability and access to credit, safety-net, and market (equation 6) are in Table 6. The results are not qualitatively different from the estimations of the occupational equation (2) for households focused on self employed agriculture. Columns (1),(2), and (3) show the consumption estimates models with interactions between rainfall variability and access to credit, safety-net and market for households in non-flood prone Upazilas.

Table 6: Effects of local rainfall variability and policy action variables on consumption welfare

	(1)	(2)	(3)
Sample:	Non-flood prone Upazilas		
Policy interactions variables	Credit	Safety-Net	Market
CV Rain CRU (β_4)	**-1.794*****	**-1.638*****	-1.242
	(-3.775)	(-3.799)	(-1.247)
Policy Action X CV Rain CRU (β_6)	0.449	-0.0903	-1.306
	(0.894)	(-0.214)	(-0.433)
Observations	3886	3886	3886
Test $\beta_4 + \beta_6 = 0$	**-1.345*****	**-1.729*****	-2.548
F Statistic	8.066	12.66	1.407
F > Prob	0.00498	0.000467	0.237

Robust t-statistics in parentheses based on PSU level clusters. *** p<0.01, ** p<0.05, * p<0.1. Full estimation results are in annex Table A9

We find that the net effect of rainfall variability and access to credit or safety-net on consumption is negative and significant (columns 4 and 5). That is, access to credit or safety-net does not completely mitigate the negative effects of rainfall variability on consumption welfare. On the other hand, we cannot reject the null that local rainfall variability has no effect on consumption in households with access to market.

6. Conclusions

When households' choices of diversity in economic activities are driven by push factors households attain income stability by sacrificing higher returns. We find that rural households in Bangladesh are pushed to diversify between sectors and employment types to cope with historical flood and local rainfall variability risks. However, our findings suggest households chose sectoral diversity to mitigate historical flood risks. That is, members of the same households choose occupations in different sectors to mitigate flood risks.

As expected, in the historically flood prone Upazilas local rainfall variability plays a less significant role in households' occupational choice decisions. On the other hand in non-flood prone Upazilas local rainfall variability plays a significant role in household occupational and employment diversity choices. In particular, households living in Upazilas with high rainfall variability are more likely to be diversified between sectors, such as agriculture versus non-agriculture, as well as between self versus wage employment choices.

We find that, in non-flood prone Upazilas households with head and non-head members self employed in agriculture enjoy higher consumption welfare as compared with the households who choose to diversify. However, households faced with higher rainfall variability are less likely to have both members self employed in agriculture. Higher rainfall variability also accounts for significantly lower consumption welfare in non-flood prone Upazilas.

Policy action variables such as access to credit and safety-net lower the likelihood of pushed occupational diversification when faced with higher rainfall variability. However, access to credit and safety-net cannot completely eliminate the households' need to diversity in order to cope with rainfall variability. The net negative effects of rainfall variability and access to credit or safety-net on consumption welfare suggests households who face higher rainfall variability but have access to credit or safety-net still face welfare loss due to *ex ante* rainfall variability.

Our results suggest access to market, on the other hand, may provide households with other strategies to cope with rainfall variability and eliminate the need to choose a lower welfare providing diverse portfolio of occupations between household members. Households in non-flood prone Upazilas who face higher rainfall variability but has access to market are as likely to have both members self employed in agriculture and have higher consumption welfare as compared with households who face less variable rainfall in non-flood prone Upazilas.

Households in Bangladesh are pushed to maintain a diverse occupational and employment portfolio to cope with local rainfall variability resulting in a loss of household welfare and productivity. Since flood water reduces dependency on local rainfall, these effects are strongest in the Upazilas not prone to flooding. While access to credit or safety-net does not completely eliminate the need to choose a lower return diverse occupational portfolio, access to market may provide alternate coping opportunities that preserve consumption welfare and occupational focus when households are faced with rainfall variability risks.

References:

Ahmad, Q. K., Chowdhury, A. K. A., Imam, S. H., and Sarker, M. 2001. *Perspectives on flood 1998*. Dhaka: The University Press Ltd.

Ahmed, A. U. and Mirza, M. M. Q. 2000. 'Review of causes and dimensions of floods with particular reference to flood '98: national perspectives' in Ahmad, Q. K., Chowdhury, A. K. A., Imam, S. H. and Sarker, M. (eds) Perspectives on Flood 1998, University Press Ltd, Dhaka, pp67–84

Auffhammer M., S.M. Hsiang, W. Schlenker, and A. Sobel. 2011 "Global Climate Models and Climate Data: a User Guide for Economists," *Working Paper*

Banerjee, Lopamudra 2007. "Effects of Flood on Agricultural Wages in Bangladesh: An Empirical Analysis." *World development,* 35, no. 11, pp1989-2009

Blankespoor, B. and Yoshida, N. 2010. *Market Accessibility in Bangladesh*. 16pp. mimeo, Washington DC, World Bank

Deaton, Angus 1992. *Understanding Consumption* Carendon Lectures in Economics, Oxford University press.

Elbers, C., J.W. Gunning, and B. Kinsey 2007. "Growth and Risk: Methodology and Micro Evidence." *The World Bank Economic Review,* 21, 1–20.

Ellis, Frank. 2004. "Occupational Diversification in Developing Countries and the Implications for Agricultural Policy" Programme of Advisory and Support Services to DFID (PASS).

Hossain, M. 2004. Rural Non-Farm Economy in Bangladesh: A View from Household Surveys. Center for Policy Dialogue (CPD) Occasional Paper Series no 40, Dhaka: Center for Policy Dialogue.

Islam, M. J., Parul, S. S., Pathan, A. B. M. B. U., Quasem, M. A., & Islam, M. S. 2004. Influence of cracking on rice seasons and irrigation in Bangladesh. Journal of Biological Sciences, 4(1), 11–14.

Jacoby, H.G., and E. Skoufias. 1997. "Risk, Financial Markets, and Human Capital in a Developing Country." *The Review of Economic Studies* 64, no. 3: 311–35.

Madhavan, M., Takamatsu S., Yshida N., 2012. "Responses to climate variability with employment in Monga areas" (mimeo)

Menon, Nidhiya 2009. "Rainfall Uncertainty and Occupational Choice in Agricultural Households of Rural Nepal" *Journal of Development Studies*, Vol. 45, no. 6 (July), pp, 864-888.

Menon Nidhiya and Narayanan Subramanian. 2008. "Learning, diversification and the nature of risk" *Economic Theory* 35: 117–145

Mirza M.M.Q. 2003. "Three Recent Extreme Floods in Bangladesh: A Hydro-Meteorological Analysis", Natural Hazards Vol. 28, pp35-64.

MoEF, 2009. Bangladesh Climate Change Strategy and Action Plan 2009. Ministry of Environment and Forests, Government of the People's Republic of Bangladesh, Dhaka, Bangladesh.

Quasem, M. A. 1992. Economic situation in ecologically favorable and non favorable areas. The Bangladesh Development Studies, XX(4), 1–14.

Reardon, T., Julio Berdegué, Christopher B. Barrett, and Kostas Stamoulis 2006. "Household Income Diversification into Rural Nonfarm Activities" in Steven Haggblade, Peter Hazell and Thomas Reardon, editors, *Transforming the Rural Nonfarm Economy,* Johns Hopkins University Press, Baltimore.

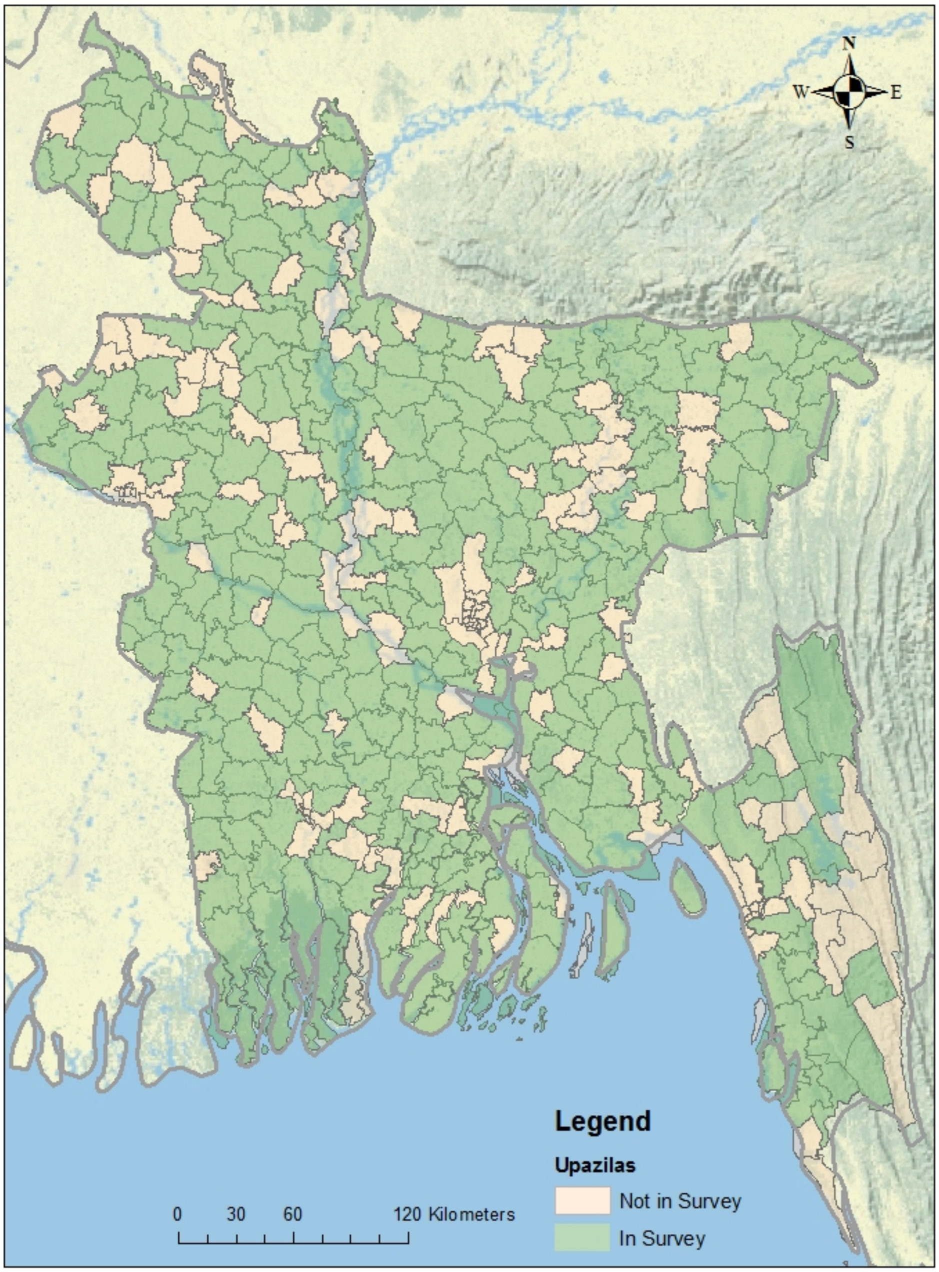
Rosenzweig, M.R., and H.P. Binswanger. 1993. Wealth, Weather Risk and the Composition and Profitability of Agricultural Investments. *The Economic Journal*, 103, no. 416: 56–78.

World Bank (2008). Poverty Assessment for Bangladesh: Creating Opportunities and Bridging the East-West Divide. Report No. 44321-BD. Washington DC.

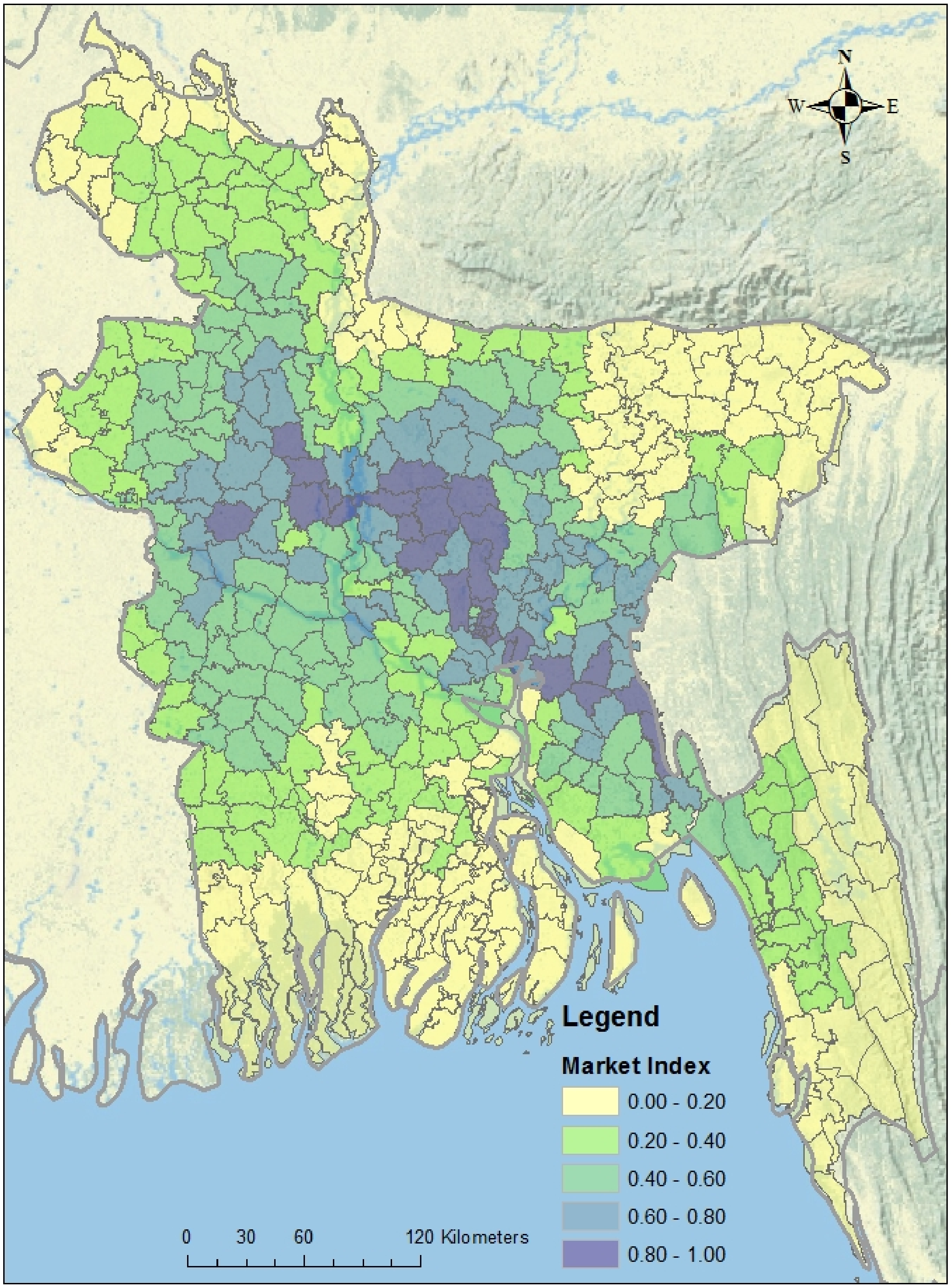
Yu, W., J. Thurlow, M. Alam, A. Hassan, A. S. Khan, A. Ruane, C. Rosenzweig, 2010 *Climate Change Risks and Food Security in Bangladesh*. London: EarthScan.

Maps

Map 1: Bangladesh HIES survey Upazilas in 2010

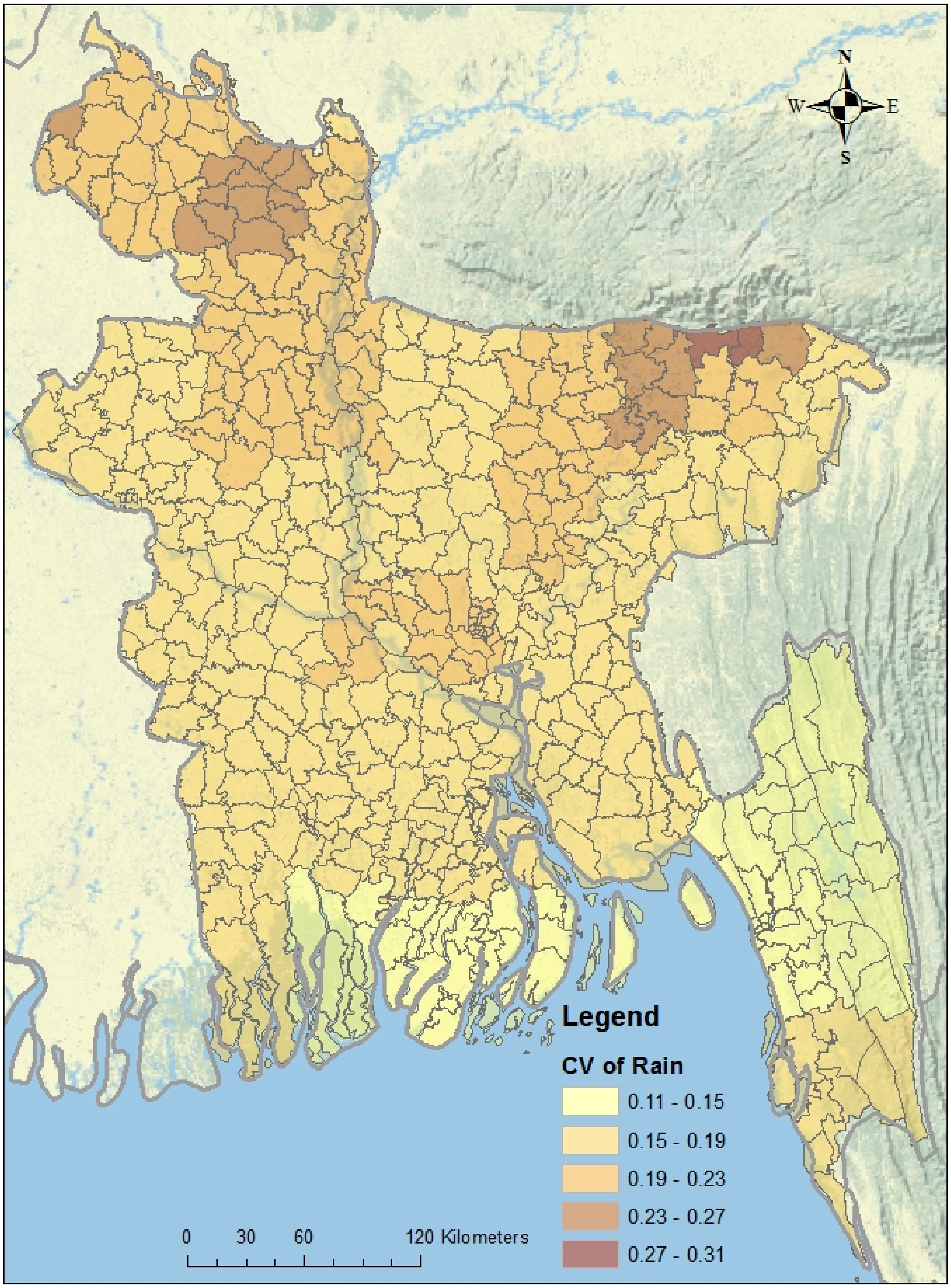


Map 2: Index of access to market in Bangladesh

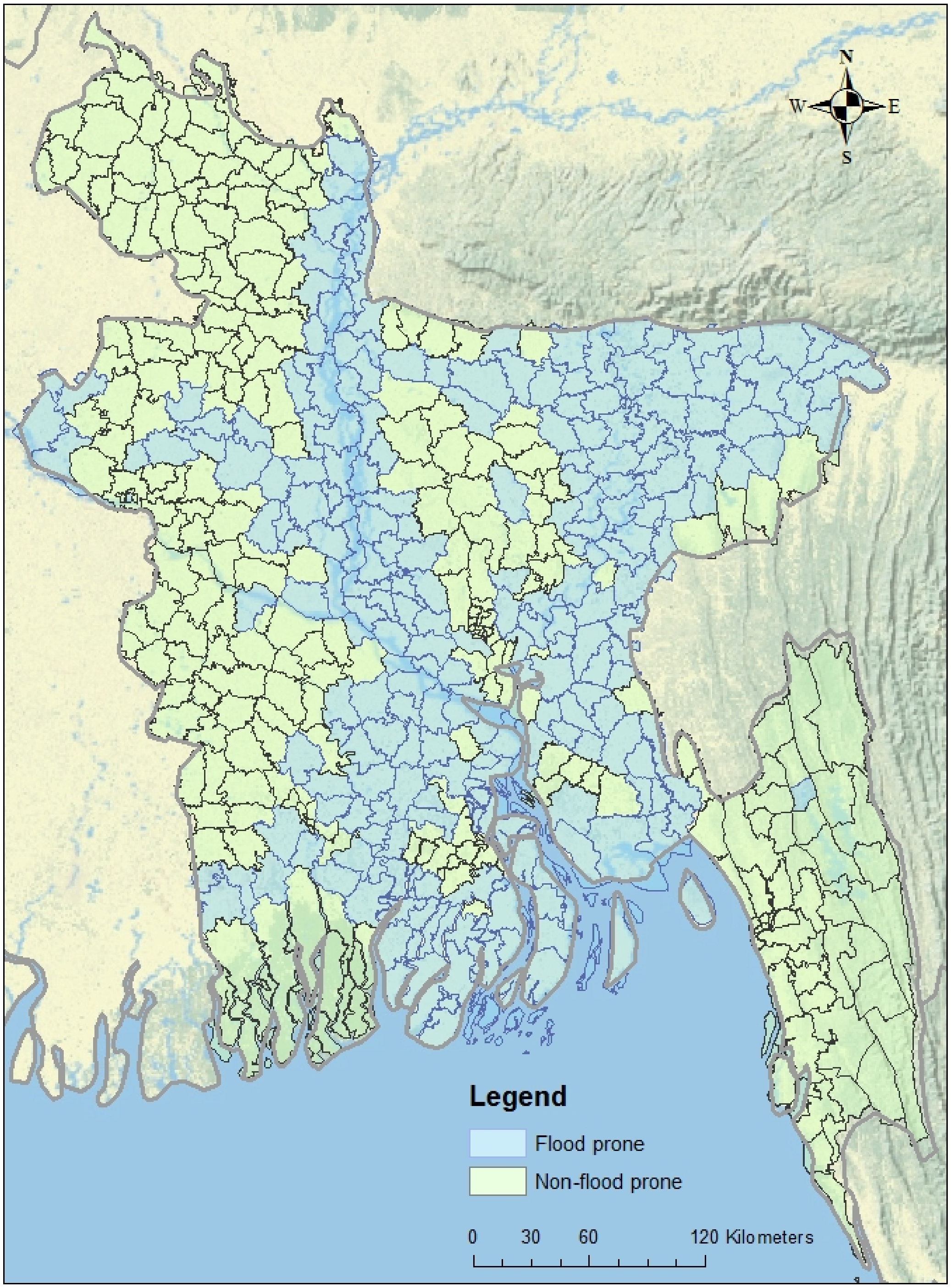


Map 3: Comparison of 0.5 degree grid, Upazilas, and rainfall stations in Bangladesh

Map 4: Local rainfall variability by Upazilas in Bangladesh



Map 5: Historically flood prone Upazilas in Bangladesh



Annex Tables

Table A1: Member, household, and Upazila level variables with descriptive statistics

Description Mean (Standard Errors)	Overall	Non Flood-prone	Flood-prone
Occupational Focus of Members Relative to the Head			
"Same Occupation as Head" takes the value 1 if the member's occupation matches that of the head of the household and 0 otherwise. Detailed occupational classification in the survey was used to define occupation matches.	0.35 (0.008)	0.39 (0.011)	0.30 (0.011)
"Same sector as Head" takes the value 1 if the member's sector matches that of the head of the household and 0 otherwise. Six sectors are defined as, agriculture, construction, transport and public utilities, manufacturing, trade and business, services, and others.	0.39 (0.008)	0.43 (0.011)	0.35 (0.011)
"Both in agriculture" takes the value 1 if both the member and the head of the household report to be engaged in agriculture and 0 otherwise.	0.33 (0.009)	0.36 (0.012)	0.29 (0.013)
"Both self employed" takes the value 1 if both the member and the head of the household report to be self employed and 0 otherwise.	0.55 (0.013)	0.57 (0.017)	0.54 (0.018)
"Both in the same sector and self employed" takes the value 1 if both the member and the head of the household report to be self employed in the same sector and 0 otherwise.	0.17 (0.006)	0.18 (0.009)	0.16 (0.009)
"Both self employed in agriculture" takes the value 1 if both the member and the head of the household report to be self employed in agriculture and 0 otherwise.	0.13 (0.006)	0.14 (0.008)	0.11 (0.007)
Other Member Characteristics			
Age in years for the member engaged in the economic activities	25.2 (0.15)	25.4 (0.21)	24.9 (0.21)
"Member is literate" takes the value 1 if the member is reported to be able to write a letter and 0 otherwise.	0.64 (0.008)	0.65 (0.011)	0.62 (0.012)
"Member is married" takes the value 1 if the member is reported to be married and 0 otherwise.	0.45 (0.008)	0.47 (0.011)	0.44 (0.012)
"Member is female" takes the value 1 if the member is female and 0 otherwise.	0.20 (0.007)	0.23 (0.010)	0.15 (0.009)
Head of Household's Characteristics			
"Age of head is 65 plus" takes the value 1 if the age of the head of the household is 65 years or more and 0 otherwise.	0.17 (0.006)	0.15 (0.008)	0.20 (0.009)
"Head is primary plus educated" takes the value 1 if the head of the household has at least 5 years of education and 0 otherwise.	0.28 (0.007)	0.27 (0.010)	0.29 (0.011)
"Head is female" takes the value 1 if the head of the household is female and 0 otherwise.	0.14 (0.006)	0.13 (0.008)	0.15 (0.009)

Table A1: Member, household, and Upazila level variables with descriptive statistics (continued)

Description Mean (Standard Errors)	Overall	Non Flood-prone	Flood-prone
Household Characteristics			
Monthly per capita Consumption in Taka	2,175 (17.09)	2,173 (23.81)	2,176 (24.55)
"Winter" takes the value 1 if the household was surveyed in December-February, and 0 otherwise	0.21 (0.005)	0.19 (0.006)	0.23 (0.007)
"Monsoon" takes the value 1 if the household was surveyed in June-September, and 0 otherwise	0.34 (0.005)	0.32 (0.007)	0.36 (0.008)
"Autumn" takes the value 1 if the household was surveyed in October-November, and 0 otherwise	0.15 (0.004)	0.16 (0.006)	0.14 (0.006)
Number of female household members in 10+ age group	1.73 (0.010)	1.68 (0.014)	1.78 (0.015)
Number of male household members in 10+ age group	1.63 (0.012)	1.63 (0.016)	1.64 (0.017)
Number of household members in age group 10-65 working in Agriculture	0.58 (0.008)	0.64 (0.012)	0.51 (0.011)
Dependency Ratio	0.48 (0.006)	0.45 (0.008)	0.51 (0.009)
Age of Head of the household	46.4 (0.16)	45.9 (0.22)	46.9 (0.23)
"Literate Head" takes the value 1 if the head is literate and 0 otherwise	0.41 (0.006)	0.43 (0.008)	0.38 (0.008)
"Female Head" takes the value 1 if the head is female and 0 otherwise	0.15 (0.004)	0.14 (0.005)	0.17 (0.006)
Share of literate members in the household	0.44 (0.004)	0.46 (0.005)	0.42 (0.005)
"Land" takes the value 1 if household owns more than mean land in sample and 0 otherwise	0.13 (0.004)	0.14 (0.006)	0.13 (0.005)
"Livestock" takes the value 1 if household owns livestock and 0 otherwise	0.75 (0.005)	0.77 (0.007)	0.73 (0.007)
"Loan" takes the value 1 if household has taken any loan in past 12 months and 0 otherwise	0.35 (0.005)	0.37 (0.008)	0.34 (0.008)
"Safety-net" takes the value 1 if any member of the household availed of safety-net programs in last 12 months and 0 otherwise	0.30 (0.005)	0.32 (0.007)	0.29 (0.008)
"Electricity" takes the value 1 if household has electricity and 0 otherwise	0.43 (0.006)	0.42 (0.008)	0.44 (0.008)
"Phone" takes the value 1 if household has cell or Landline phones and 0 otherwise	0.57 (0.006)	0.55 (0.008)	0.60 (0.008)
"Migrated" takes the value 1 if any member of the household migrated to another area in the last 5 years and 0 otherwise	0.15 (0.004)	0.12 (0.005)	0.18 (0.006)
"Shocks" takes the value 1 if household suffered from flood, tornado, unemployment, livestock disease, or agricultural theft and 0 otherwise	0.06 (0.005)	0.07 (0.004)	0.06 (0.004)

Table A1: Member, household, and Upazila level variables with descriptive statistics (continued)

Description Mean (Standard Errors)	Overall	Non Flood-prone	Flood-prone
Upazila Characteristics			
Upazila Population	267,000 (6629)	260,000 (9560)	273,000 (9195)
Access to market index 0 to 1	0.38 (0.014)	0.40 (0.018)	0.36 (0.021)
Monsoon Coefficient of Variation (Based on Stations)	0.21 (0.002)	0.22 (0.002)	0.21 (0.002)
Monsoon Coefficient of Variation (Based on CRU 3.1)	0.18 (0.002)	0.18 (0.002)	0.18 (0.002)
Historically Flooded Upazilas of 1998	0.51 (0.027)		

Table A2: List of safety net programs in Bangladesh

1-Old age Allowance (MOSW)
2-Allowance for the Widowed, Deserted and Destitute
3-Allowance for the Financially Insolvent Disabled
4-Maternity allowance Program for the Poor Lactating
5-Honorarium for Insolvent Freedom Fighters (MOFWA)
6-Honorarium for Injured Freedom Fighters
7-Gratuitous Relief (Cash)
8-General Relief Activities
9-Allowances for distressed cultural personalities/Activists
10-Allowance for beneficiaries in ctg. Hill tract area
11-Stipend for Disabled Students (MOSW)
12-Grants for the schools for the Disabled (MOSW)
13-Cash for Work (MOFDM)
14-Housing Support
15-Agriculture Rehabilitation (MOA)
16-Subsidy for open market sales (OMS)
17-Vulnerable group development (VGD) (MOWCA)
18-Vulnerable group feeding (VGF) (MOFDM)
19-Test Relief (TR) Food (MOFDM)
20-Gratuitious Relief
21-Food for work (FFW)
22-Employment Generation for Hard-core Poor or 100 days
23-Stipened for Primary Students (MOPMED)
24-School Feeding Program (MOPMED)
25-Stipend for drop out students
26-Stipened for Secondary and Higher Secondary/Female Student
27-Maternal Health Voucher Allowance
28-Rural Employment opportunities for protection of public
29-Char livelihood
30-Rural Employment, Social forestation and Rural Maintenance Program (LGD)

Table A3: Occupational focus and flood and local rainfall variability (CRU based) for full sample

	(1)	(2)	(3)	(4)	(5)	(6)
	CRU / Overall	CRU / Overall	CRU / Overall	CRU / Overall	CRU / Overall	CRU / Overall
VARIABLES	soccu	ssect	sagri	bself	ssectbse	bagrise
Age of Member	-0.000199	-0.00227	0.00125	**0.0231*** **	0.00481	-0.00391
	(-0.0334)	(-0.354)	(0.182)	(2.686)	(0.661)	(-0.485)
Dummy for female	**-0.464*** **	**-0.319* **	**-0.903*** **	**-0.566*** **	**-0.769*** **	**-0.771*** **
	(-3.066)	(-1.921)	(-4.985)	(-2.873)	(-4.035)	(-3.193)
Member is Literate	**-0.646*** **	**-0.593*** **	**-0.707*** **	0.0123	-0.142	**-0.285** **
	(-6.740)	(-6.212)	(-6.098)	(0.0841)	(-1.190)	(-2.087)
Dummy for individual is married	-0.0891	-0.0576	0.0213	**0.317** **	0.117	0.100
	(-0.952)	(-0.644)	(0.196)	(2.416)	(0.981)	(0.775)
Number 10+ Female	-0.0496	-0.0380	-0.0281	-0.0937	0.0489	0.0846
	(-0.986)	(-0.768)	(-0.457)	(-1.466)	(0.781)	(1.205)
Number 10+ Male	**-0.104** **	**-0.110** **	-0.0678	-0.0142	-0.0708	-0.0715
	(-2.119)	(-2.432)	(-1.123)	(-0.231)	(-1.168)	(-0.990)
Number of dependents	**0.132*** **	**0.134*** **	0.0812	0.0288	**0.117** **	**0.0972* **
	(3.195)	(3.273)	(1.621)	(0.568)	(2.479)	(1.685)
Age of Head 65+	**-1.015*** **	**-1.177*** **	0.00319	-0.0356	**-0.758*** **	**-0.493** **
	(-7.062)	(-8.295)	(0.0185)	(-0.198)	(-4.112)	(-2.301)
Head is Primary+ Educated	**-0.221** **	-0.0730	**-0.457*** **	**-0.275** **	**-0.276* **	**-0.424** **
	(-2.107)	(-0.686)	(-3.589)	(-1.973)	(-1.900)	(-2.499)
Dummy for female head	**-2.254*** **	**-2.142*** **	**-0.958** **	**-0.933* **	**-2.969*** **	**-2.875*** **
	(-10.33)	(-10.17)	(-2.566)	(-1.700)	(-6.640)	(-5.250)
Hhold owns more than mean land in sample	**0.716*** **	**0.567*** **	**1.417*** **	**0.985*** **	**1.615*** **	**2.102*** **
	(5.930)	(4.702)	(9.258)	(6.050)	(10.84)	(12.39)
Hhold has Electricity	**-0.321*** **	**-0.197** **	**-0.598*** **	0.0958	-0.0473	**-0.308** **
	(-3.358)	(-2.032)	(-4.544)	(0.650)	(-0.350)	(-1.968)
Cell or Landline Phone	-0.101	-0.0118	**-0.292** **	0.0161	0.197	0.174
	(-1.047)	(-0.120)	(-2.064)	(0.101)	(1.349)	(1.016)
Upazila Population	**-1.49e-06*** **	**-1.59e-06*** **	**-2.20e-06*** **	**-1.14e-06* **	**-2.16e-06*** **	**-2.47e-06*** **
	(-3.297)	(-3.556)	(-3.527)	(-1.877)	(-3.406)	(-3.135)
Flooded Upazilas 1998	**-0.331*** **	**-0.263** **	**-0.273* **	0.0717	-0.0252	-0.180
	(-3.028)	(-2.455)	(-1.833)	(0.485)	(-0.178)	(-1.049)
CV Rain CRU	-1.439	-1.237	1.076	**-8.948*** **	**-6.434*** **	**-6.330** **
	(-0.695)	(-0.601)	(0.376)	(-3.133)	(-2.602)	(-2.322)
Constant	**1.436*** **	**1.478*** **	0.773	**1.447** **	-0.0223	-0.106
	(3.444)	(3.573)	(1.255)	(2.302)	(-0.0401)	(-0.169)
Observations	3,709	3,709	2,792	1,553	3,709	3,709

Robust z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A4: Occupational focus and flood and local rainfall variability (Station based) for full sample

VARIABLES	(1) STNi Overall soccu	(2) STNi / Overall ssect	(3) STNi / Overall sagri	(4) STNi / Overall bself	(5) STNi / Overall ssectbse	(6) STNi / Overall bagrise
Age of Member	1.18e-05	-0.00206	0.000905	**0.0247*** **	0.00616	-0.00232
	(0.00197)	(-0.320)	(0.131)	(2.865)	(0.849)	(-0.288)
Dummy for female	**-0.460*** **	**-0.316* **	**-0.898*** **	**-0.521*** **	**-0.736*** **	**-0.727*** **
	(-3.012)	(-1.902)	(-4.972)	(-2.583)	(-3.671)	(-2.878)
Member is Literate	**-0.648*** **	**-0.594*** **	**-0.714*** **	-0.0212	-0.154	**-0.299** **
	(-6.773)	(-6.231)	(-6.186)	(-0.146)	(-1.296)	(-2.196)
Dummy for individual is married	-0.0901	-0.0594	0.0272	**0.323** **	0.109	0.0910
	(-0.968)	(-0.665)	(0.251)	(2.448)	(0.913)	(0.703)
Number 10+ Female	-0.0515	-0.0386	-0.0334	-0.104	0.0394	0.0744
	(-1.022)	(-0.780)	(-0.544)	(-1.629)	(0.621)	(1.044)
Number 10+ Male	**-0.103** **	**-0.109** **	-0.0629	-0.0121	-0.0694	-0.0716
	(-2.079)	(-2.415)	(-1.045)	(-0.199)	(-1.120)	(-0.964)
Number of dependents	**0.131*** **	**0.133*** **	0.0805	0.0191	**0.112** **	0.0919
	(3.165)	(3.258)	(1.584)	(0.376)	(2.391)	(1.638)
Age of Head 65+	**-1.015*** **	**-1.177*** **	0.0214	-0.0614	**-0.766*** **	**-0.507** **
	(-7.067)	(-8.303)	(0.122)	(-0.353)	(-4.097)	(-2.332)
Head is Primary+ Educated	**-0.221** **	-0.0739	**-0.454*** **	**-0.290** **	**-0.289** **	**-0.446*** **
	(-2.106)	(-0.692)	(-3.567)	(-2.087)	(-1.987)	(-2.625)
Dummy for female head	**-2.250*** **	**-2.140*** **	**-0.944** **	-0.882	**-2.975*** **	**-2.896*** **
	(-10.30)	(-10.17)	(-2.506)	(-1.479)	(-6.634)	(-5.289)
Hhold owns more than mean land in sample	**0.712*** **	**0.567*** **	**1.401*** **	**0.988*** **	**1.613*** **	**2.107*** **
	(5.826)	(4.656)	(9.113)	(5.988)	(10.35)	(11.89)
Hhold has Electricity	**-0.315*** **	**-0.193** **	**-0.604*** **	0.136	-0.0211	**-0.280* **
	(-3.274)	(-1.989)	(-4.597)	(0.924)	(-0.156)	(-1.789)
Cell or Landline Phone	-0.103	-0.0117	**-0.299** **	0.00997	0.182	0.157
	(-1.065)	(-0.119)	(-2.137)	(0.0621)	(1.254)	(0.918)
Upazila Population	**-1.47e-06*** **	**-1.60e-06*** **	**-2.02e-06*** **	**-1.09e-06* **	**-2.19e-06*** **	**-2.55e-06*** **
	(-3.192)	(-3.525)	(-3.234)	(-1.787)	(-3.252)	(-3.067)
Flooded Upazilas 1998	**-0.350*** **	**-0.272** **	**-0.328** **	-0.0437	-0.100	-0.250
	(-3.055)	(-2.470)	(-2.068)	(-0.278)	(-0.652)	(-1.323)
CV Rain Station Interpolated	-0.831	-0.123	-4.199	**-5.532** **	-2.222	-1.789
	(-0.448)	(-0.0668)	(-1.472)	(-2.021)	(-0.874)	(-0.609)
Constant	1.354***	1.282***	1.857***	1.031	-0.663	-0.807
	(3.109)	(2.992)	(2.724)	(1.466)	(-1.063)	(-1.087)
Observations	3,709	3,709	2,792	1,553	3,709	3,709

Robust z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A5: Occupational focus and flood and local rainfall variability for non-flood prone Upazilas

VARIABLES	(1) CRU Flood=0 soccu	(2) CRU Flood=0 ssect	(3) CRU Flood=0 sagri	(4) CRU Flood=0 bself	(5) CRU Flood=0 ssectbse	(6) CRU Flood=0 bagrise
Age of Member	0.00131	-0.00651	0.00772	**0.0385*****	0.00726	0.000753
	(0.170)	(-0.723)	(0.886)	(3.197)	(0.830)	(0.0829)
Dummy for female	-0.278	-0.207	**-0.800*****	**-0.503***	**-0.596*****	**-0.652****
	(-1.547)	(-0.912)	(-3.710)	(-1.893)	(-2.591)	(-2.408)
Member is Literate	**-0.484*****	**-0.470*****	**-0.448*****	0.0223	0.0184	-0.0150
	(-3.643)	(-3.520)	(-2.803)	(0.110)	(0.107)	(-0.0756)
Dummy for individual is married	-0.00162	0.00685	0.108	0.185	0.165	0.179
	(-0.0125)	(0.0544)	(0.770)	(1.017)	(1.005)	(1.065)
Number 10+ Female	-0.0814	-0.0605	-0.0342	-0.0649	0.000565	0.0409
	(-1.155)	(-0.868)	(-0.408)	(-0.710)	(0.0066)	(0.440)
Number 10+ Male	-0.0436	-0.0604	-0.141	-0.0934	-0.0482	-0.0970
	(-0.621)	(-0.886)	(-1.554)	(-1.012)	(-0.534)	(-0.866)
Number of dependents	0.0531	0.0845	0.0278	0.0532	0.0757	0.0872
	(0.856)	(1.307)	(0.401)	(0.660)	(1.050)	(1.102)
Age of Head 65+	**-0.750*****	**-0.897*****	0.179	0.0664	**-0.444***	-0.440
	(-3.526)	(-4.254)	(0.728)	(0.245)	(-1.687)	(-1.404)
Head is Primary+ Educated	-0.208	-0.0433	-0.373**	-0.367*	-0.336	-0.357
	(-1.499)	(-0.289)	(-2.204)	(-1.836)	(-1.629)	(-1.571)
Dummy for female head	**-2.090*****	**-1.861*****	**-1.103****	-0.835	**-2.709*****	**-2.678*****
	(-7.070)	(-6.515)	(-2.083)	(-0.952)	(-4.368)	(-3.522)
Hhold owns more than mean land in sample	**0.674*****	**0.554*****	**1.297*****	**0.778*****	**1.574*****	**2.043*****
	(4.505)	(3.725)	(6.249)	(3.364)	(7.570)	(8.475)
Hhold has Electricity	**-0.453*****	**-0.337****	**-0.614*****	0.308	-0.119	**-0.431****
	(-3.345)	(-2.501)	(-3.401)	(1.544)	(-0.605)	(-1.988)
Cell or Landline Phone	**-0.275****	-0.197	**-0.523*****	0.0263	**0.352***	0.363
	(-2.150)	(-1.512)	(-2.844)	(0.121)	(1.740)	(1.535)
Upazila Population	**-1.81e-06*****	**-1.70e-06*****	**-2.01e-06****	**-1.24e-06**	**-2.67e-06*****	**-2.81e-06****
	(-3.064)	(-3.074)	(-2.540)	(-1.465)	(-2.843)	(-2.499)
CV Rain CRU	**-4.365***	**-4.569***	**-4.906***	**-12.06*****	**-9.030*****	**-11.87*****
	(-1.739)	(-1.818)	(-1.669)	(-3.468)	(-2.648)	(-3.209)
Constant	1.935***	2.161***	1.806***	1.810**	0.326	0.661
	(3.922)	(4.330)	(2.770)	(2.439)	(0.461)	(0.880)
Observations	1,929	1,929	1,532	815	1,929	1,929

Robust z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A6: Occupational focus and flood and local rainfall variability for flood prone Upazilas

VARIABLES	(1) CRU Flood=1 soccu	(2) CRU Flood=1 ssect	(3) CRU Flood=1 sagri	(4) CRU Flood=1 bself	(5) CRU Flood=1 ssectbse	(6) CRU Flood=1 bagrise
Age of Member	-0.00378	0.00134	-0.00782	0.00784	0.000204	-0.0123
	(-0.392)	(0.152)	(-0.653)	(0.584)	(0.0161)	(-0.711)
Dummy for female	**-0.873*** **	**-0.557** **	**-1.478*** **	**-0.811*** **	**-1.149*** **	**-1.383*** **
	(-3.381)	(-2.432)	(-4.828)	(-2.733)	(-3.994)	(-2.789)
Member is Literate	**-0.821*** **	**-0.734*** **	**-0.961*** **	0.0644	-0.270	**-0.492** **
	(-5.877)	(-5.263)	(-5.479)	(0.292)	(-1.534)	(-2.260)
Dummy for individual is married	-0.128	-0.0697	-0.0270	**0.494** **	0.127	0.0849
	(-0.905)	(-0.521)	(-0.153)	(2.517)	(0.730)	(0.404)
Number 10+ Female	-0.0226	-0.0280	-0.0482	-0.120	0.0966	0.138
	(-0.319)	(-0.401)	(-0.559)	(-1.325)	(1.045)	(1.337)
Number 10+ Male	**-0.224*** **	**-0.201*** **	-0.0674	0.0342	-0.122	-0.0864
	(-3.319)	(-3.370)	(-0.879)	(0.427)	(-1.436)	(-0.875)
Number of dependents	**0.178*** **	**0.156*** **	0.0866	-0.00830	**0.131** **	0.0654
	(3.410)	(3.052)	(1.171)	(-0.132)	(2.111)	(0.786)
Age of Head 65+	**-1.261*** **	**-1.443*** **	-0.124	-0.135	-1.007***	-0.432
	(-6.502)	(-7.415)	(-0.513)	(-0.586)	(-4.077)	(-1.480)
Head is Primary+ Educated	-0.210	-0.0835	**-0.561*** **	-0.172	-0.176	**-0.492* **
	(-1.259)	(-0.538)	(-2.807)	(-0.854)	(-0.850)	(-1.915)
Dummy for female head	**-2.465*** **	**-2.516*** **	-0.559	-1.039	**-3.275*** **	**-3.169*** **
	(-7.881)	(-9.015)	(-1.247)	(-1.543)	(-5.287)	(-4.440)
Hhold owns more than mean land in sample	**0.799*** **	**0.628*** **	**1.673*** **	**1.265*** **	**1.669*** **	**2.186*** **
	(4.066)	(3.186)	(7.366)	(5.701)	(8.758)	(10.25)
Hhold has Electricity	-0.138	-0.0196	**-0.544*** **	-0.0203	0.0589	-0.115
	(-0.992)	(-0.138)	(-2.770)	(-0.0911)	(0.320)	(-0.506)
Cell or Landline Phone	0.209	0.287*	0.0814	-0.0151	0.0479	-0.0365
	(1.392)	(1.903)	(0.360)	(-0.0615)	(0.224)	(-0.146)
Upazila Population	-2.56e-07	-7.50e-07	-1.12e-06	-6.97e-07	-1.04e-06	-7.97e-07
	(-0.408)	(-1.058)	(-1.255)	(-0.856)	(-1.385)	(-0.807)
CV Rain CRU	4.733	4.906	**12.25*** **	-3.293	-1.062	3.710
	(1.486)	(1.511)	(2.683)	(-0.754)	(-0.332)	(1.064)
Constant	-0.175	-0.155	-1.694*	0.615	-1.030	-2.181**
	(-0.273)	(-0.232)	(-1.774)	(0.632)	(-1.453)	(-2.475)
Observations	1,780	1,780	1,260	738	1,780	1,780

Robust z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A7: Interaction between flood prone Upazilas and policy action variables

VARIABLES	(1) soccu	(2) soccu	(3) soccu	(4) ssect	(5) ssect	(6) ssect
Age of Member	-0.000244	0.000110	-0.000520	-0.00230	-0.00186	-0.00246
	(-0.0410)	(0.0186)	(-0.0858)	(-0.360)	(-0.290)	(-0.380)
Dummy for female	**-0.463*** **	**-0.464*** **	**-0.497*** **	**-0.317***	**-0.319***	**-0.337** **
	(-3.064)	(-3.095)	(-3.307)	(-1.920)	(-1.948)	(-2.006)
Member is Literate	**-0.645*** **	**-0.648*** **	**-0.651*** **	**-0.591*** **	**-0.597*** **	**-0.595*** **
	(-6.732)	(-6.750)	(-6.807)	(-6.206)	(-6.241)	(-6.253)
Dummy for individual is married	-0.0892	-0.0931	-0.0723	-0.0579	-0.0634	-0.0490
	(-0.954)	(-0.994)	(-0.766)	(-0.647)	(-0.701)	(-0.544)
Number 10+ Female	-0.0497	-0.0476	-0.0493	-0.0387	-0.0354	-0.0373
	(-0.989)	(-0.941)	(-0.985)	(-0.782)	(-0.711)	(-0.755)
Number 10+ Male	**-0.104** **	**-0.109** **	**-0.119** **	**-0.109** **	**-0.116*** **	**-0.117*** **
	(-2.110)	(-2.222)	(-2.446)	(-2.416)	(-2.589)	(-2.618)
Number of dependents	**0.132*** **	**0.134*** **	**0.124*** **	**0.134*** **	**0.138*** **	**0.130*** **
	(3.199)	(3.238)	(3.006)	(3.283)	(3.337)	(3.186)
Age of Head 65+	**-1.017*** **	**-1.020*** **	**-1.011*** **	**-1.180*** **	**-1.185*** **	**-1.173*** **
	(-7.068)	(-7.089)	(-7.045)	(-8.292)	(-8.337)	(-8.287)
Head is Primary+ Educated	**-0.220** **	**-0.234** **	**-0.231** **	-0.0727	-0.0926	-0.0769
	(-2.104)	(-2.224)	(-2.179)	(-0.681)	(-0.861)	(-0.714)
Dummy for female head	**-2.259*** **	**-2.255*** **	**-2.276*** **	**-2.147*** **	**-2.145*** **	**-2.152*** **
	(-10.34)	(-10.28)	(-10.44)	(-10.20)	(-10.13)	(-10.16)
Hhold owns more than mean land in sample	**0.710*** **	**0.706*** **	**0.723*** **	**0.562*** **	**0.554*** **	**0.572*** **
	(5.880)	(5.865)	(5.846)	(4.653)	(4.620)	(4.667)
Hhold has Electricity	**-0.322*** **	**-0.340*** **	**-0.268*** **	**-0.197** **	**-0.223** **	**-0.173***
	(-3.362)	(-3.529)	(-2.776)	(-2.037)	(-2.273)	(-1.829)
Cell or Landline Phone	-0.0997	-0.105	-0.0721	-0.00978	-0.0179	0.00511
	(-1.032)	(-1.095)	(-0.747)	(-0.0995)	(-0.183)	(0.0522)
Thana Population	**-1.49e-06*** **	**-1.57e-06*** **	**-1.09e-06** **	**-1.58e-06*** **	**-1.70e-06*** **	**-1.39e-06*** **
	(-3.289)	(-3.465)	(-2.447)	(-3.537)	(-3.791)	(-3.138)

Table A7: Interaction between flood prone Upazilas and policy action variables (Continued)

VARIABLES	(1) soccu	(2) soccu	(3) soccu	(4) ssect	(5) ssect	(6) ssect
flooded thana 1998	**-0.353*** **	**-0.372*** **	**-0.623*** **	**-0.318** **	**-0.322*** **	**-0.450** **
	(-2.702)	(-2.906)	(-3.419)	(-2.461)	(-2.581)	(-2.406)
Monsoon Coefficient of Variation	-1.402	-1.678	-0.667	-1.164	-1.576	-0.800
	(-0.677)	(-0.821)	(-0.326)	(-0.567)	(-0.775)	(-0.390)
Household with any loan	-0.0626			-0.108		
	(-0.497)			(-0.891)		
Loan X Flood-prone	0.0505			0.129		
	(0.280)			(0.768)		
Household safety-net dummy		**-0.223***			**-0.319*** **	
		(-1.737)			(-2.608)	
Safety-net X Flood-prone		0.105			0.151	
		(0.562)			(0.828)	
Access to market: Thana level			**-0.908*** **			-0.505
			(-2.899)			(-1.638)
Market X Flood-prone			**0.729***			0.472
			(1.717)			(1.047)
Constant	**1.457*** **	**1.594*** **	**1.556*** **	**1.508*** **	**1.704*** **	**1.547*** **
	(3.502)	(3.829)	(3.687)	(3.650)	(4.142)	(3.728)
Observations	3,709	3,709	3,709	3,709	3,709	3,709
b4+b6 = 0	**-0.303** **	**-0.267***	0.107	-0.189	-0.170	0.0223
Chi2	3.879	2.746	0.127	1.745	1.158	0.00494
Chi2 > Prob	0.0489	0.0975	0.721	0.187	0.282	0.944

Robust z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A8: Local rainfall variability interactions with policy action variables in non flood prone Upazilas

VARIABLES	(1) ssect	(2) ssect	(3) ssect	(4) bself	(5) bself	(6) bself
Age of Member	-0.00666	-0.00628	-0.00667	**0.0386*****	**0.0387*****	**0.0384*****
	(-0.740)	(-0.696)	(-0.739)	(3.191)	(3.157)	(3.151)
Dummy for female	-0.210	-0.210	-0.216	**-0.507***	-0.444	**-0.491***
	(-0.936)	(-0.942)	(-0.933)	(-1.901)	(-1.636)	(-1.814)
Member is Literate	**-0.468*****	**-0.477*****	**-0.472*****	0.0246	-0.00247	0.0125
	(-3.514)	(-3.568)	(-3.535)	(0.121)	(-0.0120)	(0.0616)
Member is Married	0.00768	0.00939	0.0128	0.190	0.194	0.177
	(0.0610)	(0.0735)	(0.102)	(1.046)	(1.074)	(0.980)
Number 10+ Female	-0.0612	-0.0560	-0.0598	-0.0663	-0.0652	-0.0646
	(-0.880)	(-0.792)	(-0.860)	(-0.734)	(-0.740)	(-0.713)
Number 10+ Male	-0.0599	-0.0702	-0.0661	-0.0914	-0.111	-0.103
	(-0.878)	(-1.038)	(-0.973)	(-1.001)	(-1.203)	(-1.099)
Number of dependents	0.0842	0.0902	0.0814	0.0517	0.0466	0.0576
	(1.306)	(1.389)	(1.263)	(0.640)	(0.580)	(0.720)
Age of Head 65+	**-0.897*****	**-0.917*****	**-0.894*****	0.0682	0.113	0.0725
	(-4.224)	(-4.327)	(-4.261)	(0.248)	(0.419)	(0.269)
Head is Primary+ Educated	-0.0397	-0.0616	-0.0470	**-0.376***	**-0.344***	**-0.371***
	(-0.264)	(-0.407)	(-0.312)	(-1.890)	(-1.685)	(-1.846)
Dummy for female head	**-1.872*****	**-1.878*****	**-1.871*****	-0.840	-1.022	-0.863
	(-6.573)	(-6.507)	(-6.468)	(-0.933)	(-1.233)	(-0.989)
Owns more than mean land	**0.538*****	**0.534*****	**0.560*****	**0.790*****	**0.777*****	**0.782*****
	(3.602)	(3.619)	(3.718)	(3.414)	(3.397)	(3.391)
Hhold has Electricity	**-0.335****	**-0.387*****	**-0.321****	0.307	0.279	0.305
	(-2.489)	(-2.841)	(-2.394)	(1.534)	(1.368)	(1.532)
Cell or Landline Phone	-0.194	-0.198	-0.188	0.0196	0.00461	0.0231
	(-1.486)	(-1.535)	(-1.444)	(0.0918)	(0.0216)	(0.106)
Upazila Population	**-1.70e-06*****	**-1.89e-06*****	**-1.56e-06*****	-1.23e-06	-1.35e-06	-1.24e-06
	(-3.068)	(-3.405)	(-2.662)	(-1.464)	(-1.556)	(-1.343)
CV Rain CRU (b_4)	**-5.404***	**-5.537****	-3.787	**-11.90*****	**-16.57*****	-7.575
	(-1.898)	(-2.058)	(-0.794)	(-2.712)	(-3.703)	(-0.981)
Access to Credit	-0.491			0.263		
	(-0.664)			(0.200)		

Table A8: Local rainfall variability interactions with policy action variables in non flood prone Upazilas

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ssect	ssect	ssect	bself	bself	bself
Credit X CV Rain CRU (b_6)	2.286			-0.938		
	(0.569)			(-0.135)		
Access to Safety-net		-0.673			**-2.466****	
		(-1.072)			(-2.210)	
Safety-net X CV Rain CRU (b_6)		1.709			**12.83****	
		(0.508)			(2.130)	
Access to Market			0.144			2.861
			(0.0555)			(0.659)
Market X CV Rain CRU (b_6)			-2.062			-16.26
			(-0.145)			(-0.701)
Constant	**2.346*****	**2.556*****	**2.082****	**1.736***	**2.792*****	1.091
	(4.355)	(4.951)	(2.348)	(1.942)	(3.142)	(0.782)
Observations	1,929	1,929	1,929	815	815	815
Test $b_4+b_6 = 0$	-3.118	-3.828	-5.849	**-12.84****	-3.737	-23.83
χ^2 (1)	0.736	1.289	0.314	5.231	0.615	2.051
χ2 > Prob	0.391	0.256	0.575	0.0222	0.433	0.152

Robust z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A8: Local rainfall variability interactions with policy action variables in non flood prone Upazilas

VARIABLES	(7) ssectbse	(8) ssectbse	(9) ssectbse	(10) bagrise	(11) bagrise	(12) bagrise
Age of Member	0.00716	0.00799	0.00753	0.000736	0.00116	0.000872
	(0.808)	(0.903)	(0.866)	(0.0804)	(0.127)	(0.0966)
Dummy for female	**-0.615*** **	**-0.605*** **	**-0.610*** **	**-0.657** **	**-0.657** **	**-0.668** **
	(-2.726)	(-2.601)	(-2.672)	(-2.472)	(-2.417)	(-2.476)
Member is Literate	0.0163	0.0173	0.0234	-0.0159	-0.0151	-0.0137
	(0.0940)	(0.101)	(0.135)	(-0.0797)	(-0.0755)	(-0.0685)
Member is Married	0.171	0.165	0.170	0.180	0.178	0.186
	(1.046)	(1.010)	(1.031)	(1.082)	(1.064)	(1.109)
Number 10+ Female	0.000612	0.00506	-0.00247	0.0408	0.0429	0.0386
	(0.00715)	(0.0583)	(-0.0288)	(0.437)	(0.461)	(0.418)
Number 10+ Male	-0.0498	-0.0580	-0.0418	-0.0975	-0.101	-0.0956
	(-0.550)	(-0.651)	(-0.464)	(-0.872)	(-0.916)	(-0.866)
Number of dependents	0.0729	0.0778	0.0736	0.0863	0.0874	0.0839
	(1.009)	(1.067)	(1.011)	(1.096)	(1.104)	(1.057)
Age of Head 65+	-0.429	**-0.462***	**-0.445***	-0.437	-0.448	-0.437
	(-1.619)	(-1.731)	(-1.701)	(-1.388)	(-1.421)	(-1.407)
Head is Primary+ Educated	-0.329	**-0.355***	-0.327	-0.356	-0.364	-0.355
	(-1.591)	(-1.699)	(-1.592)	(-1.556)	(-1.591)	(-1.559)
Dummy for female head	**-2.697*** **	**-2.742*** **	**-2.703*** **	**-2.675*** **	**-2.692*** **	**-2.681*** **
	(-4.364)	(-4.512)	(-4.368)	(-3.526)	(-3.593)	(-3.536)
Owns more than mean land	**1.580*** **	**1.552*** **	**1.566*** **	**2.046*** **	**2.030*** **	**2.044*** **
	(7.831)	(7.581)	(7.398)	(8.846)	(8.506)	(8.380)
Electricity	-0.114	-0.162	-0.109	**-0.429** **	**-0.448** **	**-0.417***
	(-0.577)	(-0.809)	(-0.548)	(-1.978)	(-2.033)	(-1.886)
Cell or Landline Phone	**0.349***	**0.355***	**0.359***	0.362	0.365	0.373
	(1.745)	(1.744)	(1.765)	(1.567)	(1.538)	(1.568)
Upazila Population	**-2.65e-06*** **	**-2.88e-06*** **	**-2.62e-06*** **	**-2.80e-06** **	**-2.89e-06** **	**-2.69e-06** **
	(-2.820)	(-2.988)	(-2.780)	(-2.499)	(-2.523)	(-2.456)
CV Rain CRU (b_4)	**-11.19** **	**-10.10** **	**-15.20** **	**-12.37** **	**-12.22*** **	**-14.79***
	(-2.436)	(-2.411)	(-2.225)	(-2.411)	(-2.678)	(-1.887)
Access to Credit	-0.727			-0.163		
	(-0.642)			(-0.125)		
Credit X CV Rain CRU (b_6)	4.837			1.144		
	(0.786)			(0.163)		
Access to Safety-net		-0.694			-0.242	
		(-0.789)			(-0.246)	

Table A8: Local rainfall variability interactions with policy action variables in non flood prone Upazilas

	(7)	(8)	(9)	(10)	(11)	(12)
VARIABLES	ssectbse	ssectbse	ssectbse	bagrise	bagrise	bagrise
Safety-net X CV Rain CRU (b_6)		1.947			0.521	
		(0.397)			(0.0947)	
Access to Market			-4.077			-2.216
			(-1.048)			(-0.504)
Market X CV Rain CRU (b_6)			23.05			11.79
			(1.082)			(0.492)
Constant	0.645	0.714	1.339	0.732	0.808	1.166
	(0.714)	(0.872)	(1.070)	(0.722)	(0.883)	(0.814)
Observations	1,929	1,929	1,929	1,929	1,929	1,929
Test b_4+b_6 = 0	-6.350	**-8.150***	7.853	**-11.22****	**-11.70****	-2.998
χ^2 (1)	1.928	3.685	0.249	5.391	6.305	0.0297
χ2 > Prob	0.165	0.0549	0.618	0.0202	0.0120	0.863

Robust z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table A9: Effects of flood and local rainfall variability risks on consumption welfare

VARIABLES	(1) Overall lp_cons	(2) Flood=0 lp_cons	(3) Flood=1 lp_cons	(4) Flood=0 lp_cons	(5) Flood=0 lp_cons	(6) Flood=0 lp_cons
Winter (December-February)	0.00425	0.0187	-0.00288	0.0184	0.0208	0.0172
	(0.159)	(0.540)	(-0.0741)	(0.532)	(0.602)	(0.488)
Monsoon (June-September)	**0.0433***	0.0241	**0.0730****	0.0242	0.0269	0.0233
	(1.948)	(0.847)	(2.234)	(0.851)	(0.957)	(0.822)
Autumn (October-November)	0.0430	**0.130*****	-0.0452	**0.130*****	**0.130*****	**0.126*****
	(1.412)	(3.154)	(-1.169)	(3.154)	(3.178)	(3.088)
Number 10+ Female	**-0.0980*****	**-0.0920*****	**-0.108*****	**-0.0918*****	**-0.0887*****	**-0.0921*****
	(-16.94)	(-11.55)	(-13.49)	(-11.53)	(-11.15)	(-11.52)
Number 10+ Male	**-0.0783*****	**-0.0981*****	**-0.0635*****	**-0.0976*****	**-0.0977*****	**-0.0981*****
	(-11.97)	(-10.41)	(-7.190)	(-10.34)	(-10.40)	(-10.57)
Dependency Ratio	**-0.202*****	**-0.215*****	**-0.194*****	**-0.216*****	**-0.213*****	**-0.215*****
	(-17.39)	(-12.66)	(-12.38)	(-12.69)	(-12.71)	(-12.88)
Age of Head	**0.00460*****	**0.00480*****	**0.00445*****	**0.00478*****	**0.00502*****	**0.00480*****
	(11.69)	(8.416)	(8.449)	(8.350)	(8.914)	(8.444)
Head is Literate	**0.0273****	0.0251	0.0252	0.0248	0.0260	0.0249
	(2.002)	(1.375)	(1.299)	(1.365)	(1.435)	(1.363)
Dummy for female head	**-0.0249***	**-0.0574*****	-0.000751	**-0.0587*****	**-0.0531****	**-0.0577*****
	(-1.655)	(-2.695)	(-0.0363)	(-2.774)	(-2.517)	(-2.743)
Share Literate	**0.271*****	**0.245*****	**0.311*****	**0.244*****	**0.237*****	**0.245*****
	(10.19)	(6.327)	(8.748)	(6.336)	(6.101)	(6.348)
Owns more than mean land	**0.273*****	**0.262*****	**0.290*****	**0.261*****	**0.255*****	**0.262*****
	(15.31)	(11.26)	(10.52)	(11.12)	(11.02)	(11.27)
Number 10-65 in Agriculture	**-0.0268*****	**-0.0212***	**-0.0319****	**-0.0216***	**-0.0194***	**-0.0214***
	(-3.146)	(-1.886)	(-2.572)	(-1.912)	(-1.698)	(-1.884)
Household has Electricity	**0.139*****	**0.146*****	**0.133*****	**0.146*****	**0.139*****	**0.147*****
	(9.891)	(7.644)	(6.558)	(7.610)	(7.362)	(7.555)
Cell or Landline Phone	**0.210*****	**0.220*****	**0.194*****	**0.221*****	**0.217*****	**0.220*****
	(19.48)	(14.66)	(13.00)	(14.64)	(14.32)	(14.85)
Upazila Population	-1.69e-08	7.55e-08	-1.04e-07	7.77e-08	5.23e-08	7.85e-08
	(-0.191)	(0.615)	(-0.851)	(0.633)	(0.427)	(0.616)
Livestock Dummy	**0.0444*****	**0.0498*****	**0.0401****	**0.0510*****	**0.0536*****	**0.0494*****
	(3.543)	(2.995)	(2.215)	(3.090)	(3.273)	(2.912)
Member migrated (5yrs)	**0.159*****	**0.185*****	**0.141*****	**0.185*****	**0.177*****	**0.186*****
	(9.239)	(7.366)	(6.221)	(7.343)	(6.982)	(7.312)
12m Shocks: Any of 5	**-0.0423***	-0.0369	-0.0277	-0.0363	-0.0235	-0.0364
	(-1.705)	(-1.004)	(-0.805)	(-0.986)	(-0.666)	(-1.008)

Table A9: (Continues) Effects of flood and local rainfall variability risks on consumption welfare

VARIABLES	(1) Overall lp_cons	(2) Flood=0 lp_cons	(3) Flood=1 lp_cons	(4) Flood=0 lp_cons	(5) Flood=0 lp_cons	(6) Flood=0 lp_cons
Flooded Upazilas 1998	0.0141					
	(0.734)					
CV Rain CRU (β_4)	**-1.109*** **	**-1.642*** **	-0.432	**-1.794*** **	**-1.638*** **	-1.242
	(-2.891)	(-4.020)	(-0.625)	(-3.775)	(-3.799)	(-1.247)
Access to Credit				-0.0926		
				(-0.991)		
Credit X CV Rain CRU (β_6)				0.449		
				(0.894)		
Access to Safety-net					-0.0655	
					(-0.837)	
Safety-net X CV Rain CRU (β_6)					-0.0903	
					(-0.214)	
Access to Market						0.230
						(0.418)
Market X CV Rain CRU (β_6)						-1.306
						(-0.433)
Constant	**7.530*** **	**7.611*** **	**7.444*** **	**7.641*** **	**7.627*** **	**7.543*** **
	(98.57)	(86.37)	(53.19)	(78.38)	(82.09)	(41.93)
Observations	7,697	3,886	3,811	3,886	3,886	3,886
R^2	0.361	0.375	0.365	0.375	0.381	0.375
Test $\beta_4 + \beta_6 = 0$				**-1.345*** **	**-1.729*** **	-2.548
F Statistic				8.066	12.66	1.407
F > Prob				0.00498	0.000467	0.237

Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A10: Occupational focus and consumption IV estimations in non-flood Upazilas

VARIABLES	(1) IV 1st bself	(2) IV 2nd lp_cons	(3) IV 1st ssectbse	(4) IV 2nd lp_cons	(5) IV 1st bagrise	(6) IV 2nd lp_cons
season==Winter (December-February)	0.0812	-0.0126	0.00762	0.0459	0.0177	0.0324
	(1.313)	(-0.113)	(0.191)	(0.728)	(0.613)	(0.663)
season==Monsoon (June-September)	-0.104**	0.123	-0.0420	0.0844	-0.0437*	0.0819
	(-2.010)	(1.183)	(-1.434)	(1.363)	(-1.827)	(1.595)
season==Autumn (October-November)	0.0389	0.0994	-0.00127	0.105	-0.0256	0.139**
	(0.569)	(0.962)	(-0.0344)	(1.575)	(-1.118)	(2.377)
Number 10+ Female	-0.000512	-0.0405	0.0144	-0.0846***	0.0108	-0.0779***
	(-0.0243)	(-1.426)	(1.255)	(-3.619)	(1.185)	(-4.331)
Number 10+ Male	0.0143	-0.0789***	0.0218	-0.102***	-0.000411	-0.0681***
	(0.681)	(-2.663)	(1.640)	(-3.997)	(-0.0376)	(-3.982)
Dependency Ratio	0.111**	-0.412***	0.0693**	-0.353***	0.0714***	-0.348***
	(2.052)	(-3.936)	(2.502)	(-5.808)	(2.832)	(-6.237)
Age of Head	-0.000777	0.00378*	-0.00163*	0.00581***	-0.000739	0.00435***
	(-0.436)	(1.761)	(-1.964)	(3.916)	(-0.993)	(3.726)
Head is Literate	-0.0224	0.00274	-0.00769	0.00792	0.0137	-0.0232
	(-0.438)	(0.0376)	(-0.279)	(0.170)	(0.581)	(-0.590)
Dummy for female head	-0.245*	0.162	-0.0887***	0.0912	-0.0312	-0.000392
	(-1.701)	(0.765)	(-4.186)	(1.301)	(-1.609)	(-0.00866)
Share Literate	-0.0568	0.368***	-0.0147	0.343***	0.0111	0.305***
	(-0.582)	(2.608)	(-0.337)	(4.280)	(0.310)	(4.386)
Hhold owns more than mean land	0.105**	0.0585	0.239***	-0.126	0.236***	-0.0931
	(2.438)	(0.693)	(6.322)	(-0.815)	(6.687)	(-0.798)
Number 10-65 in Agriculture	0.131***	-0.155	0.117***	-0.181**	0.168***	-0.240***
	(5.621)	(-1.604)	(8.262)	(-2.395)	(12.75)	(-2.782)
Hhold has Electricity	0.133***	-0.0395	0.0368	0.0949*	0.0196	0.124***
	(2.910)	(-0.397)	(1.469)	(1.849)	(1.050)	(3.324)
Cell or Landline Phone	0.0306	0.0930	0.0403*	0.0977**	0.0363*	0.108***
	(0.676)	(1.496)	(1.791)	(2.062)	(1.906)	(2.923)
Thana Population	-1.35e-07	3.13e-07	-1.82e-07*	3.25e-07	-7.59e-08	1.53e-07
	(-0.761)	(1.007)	(-1.893)	(1.350)	(-1.084)	(0.917)
Livestock Dummy	-0.0868	0.154	0.0272	0.0157	0.0466***	-0.00862
	(-1.150)	(1.285)	(1.166)	(0.374)	(2.676)	(-0.236)
Member of household migrated (5yrs)	0.0525	0.0937	0.00345	0.139***	0.0116	0.128**
	(0.923)	(1.131)	(0.119)	(2.619)	(0.427)	(2.458)
12m Shocks: Any of 5	-0.0286	-0.0468	-0.0176	-0.0143	0.00393	-0.0467
	(-0.367)	(-0.419)	(-0.401)	(-0.185)	(0.101)	(-0.694)
Monsoon Coefficient of Variation	**-1.609****		**-1.076****		**-1.165*****	
	(-2.066)		(-2.398)		(-3.217)	
Occupational Focus Variables (a)		**1.160***		**1.530****		**1.414*****
		(1.876)		(2.422)		(2.917)
Constant	0.768***	6.747***	0.239*	7.172***	0.109	7.383***
	(4.071)	(18.84)	(1.939)	(59.18)	(1.046)	(65.60)
Observations	591	591	1,425	1,425	1,425	1,425
R-squared	0.183	-0.809	0.240	-0.929	0.373	-0.375
Endogeneity Test		**6.087****		**9.409*****		**9.199*****

Robust t-statistics in parentheses, *** p<0.01, ** p<0.05, * p<0.1 (a) Occupational focus variables are both self employed (Columns, 1,2), both self employed in the same sector (columns 3, 4), and both in agriculture (columns 5, 6). Note: The dependent variable is “log of monthly per capita consumption expenditure”.

Sushenjit Bandyopadhyay

M:\Sushenjit\Bangladesh\Occupation\Docs\Flood rain occupation Bangladesh Paper v009.docx

10/31/2012 10:07:00 AM