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**Protective Actions against Low Probability & High Loss
Events: Empirical Evidence from a Least Developed
Country**

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Abstract

Despite widespread research over the past 30 years, the construct of consumer preference associated with mitigation actions against low probability high loss (LPHL) events remain unexplored. In this paper, we build upon the steadily growing number of experimental and empirical studies in the domain of LPHL events and estimate a demand model for a hypothetical catastrophe insurance in one of the poorest and most disaster prone countries in the world. In a large-scale household survey carried out in 2006 we ask 3,000 residents in six different districts facing various level of exogenous (environmental) risk exposure level about their decision to participate in a catastrophe insurance programme. Combining environmental risk theory with the socio-economic context of the current case study we develop and test our own analytical model. We show that, as predicted by standard microeconomic theory, household decision to participate in the insurance programme varies positively with both exogenous and endogenous risk exposure level. Ability to pay, measured in terms of household wealth and access to credit, substantially constrain insurance demand. Furthermore, among the socio-demographic factors, respondent's education and occupation have been found to have significant and theoretically expected influence on the household decision making. Our study suggests that low demand for insurance against catastrophic events in a least developed economy can be better explained by the high rate of illiteracy and limited access to credit. Extension of credit facilities and investment in basic education may ensure widespread participation in the insurance programme.

Key Words: low probability high loss, catastrophe, insurance, risk, Bangladesh

Introduction

Weather related risk is a major source of income fluctuations for rural households in Bangladesh. Both coastal as well as inland habitants in Bangladesh face increased risk of natural disasters due to its geographical location and very low land elevation. Catastrophic events like riverine floods and coastal cyclones cause asset loss, crop damage, unemployment, diseases and fatalities once in every five to ten years. Following the overwhelming success of micro-credit in Bangladesh, there is a growing optimism in micro-insurance solutions to protect rural households from income shocks resulting from catastrophic risks. The aim of the proposed disaster micro-insurance is to spread the risks of natural disasters especially for the poor counterpart of the population in order to make them better prepared to cope with increased climatic disasters such as floods, cyclones and storm surges. Whilst the use of micro-insurance to cover life and health risks is prevalent to some extent, the use of micro-insurance to hedge against natural disaster losses in rural areas of Bangladesh is still only emerging. The National Adaptation Programme of Action (2005), prepared by the Ministry of Environment and Forests (MoEF), suggests exploring options for spreading natural disaster risks by investigating the potential of a flood insurance market as an important alternative poverty alleviation and natural disaster risk coping strategy.

Although insurance is often referred to as an effective tool for reducing, sharing or spreading risk of catastrophic events (Bouwer and Vellinga, 2002; Hoff et al., 2003; Mills, 2004), available evidence indicates that the demand for such insurances is substantially low throughout the world (Goes and Skees, 2003). The causes of under insurance against natural disaster losses have gained significant amount of intellectual attention in the literature of risk and uncertainty over the past 30 years (Kunruether, 1978, 1996; Shogren and Crocker, 1999; Shogren, 1990; Viscusi, 1992; Cook and Graham, 1975; Dong, Shah and Wong, 1996; Dixit, 1990; Arrow, 1996, Browne

and Hoyt, 2000; Ganderton et al., 2000). However, until now, the underlying preference pattern associated with the decision process of taking protection against catastrophic losses remains unrevealed (Camerer and Kunreuther, 1989).

Kunreuther (1978) identifies a number of low probability situations in which people fail to purchase insurance, even when it is available at low cost. According to the US Senate Republican Policy Committee Report (2006), fewer than 30 per cent of vulnerable homeowners in USA purchased insurance against flood peril despite the large number of explicit and implicit subsidies provided by the National Flood Insurance Programme (NFIP). In view of the low demand for flood insurance, US Congress is currently considering to enact a mandatory insurance purchase requirement for homeowners and businesses (US Senate Republican Policy Committee, 2006). The scenario of mitigation actions against catastrophic events is even more mysterious in a developing country context. A case study by Gine et al. (2007) shows that fewer than five per cent of the eligible farmers in a drought prone region in India bought inexpensive rainfall insurance. The study, furthermore, reveals that the offered insurance scheme failed to attract the target group of farmers and that the insurance was purchased by the farmers who needed it least.

Given the unpredictable and inconsistent nature of consumer behaviour in the context of mitigation actions against catastrophic events, the current study aims to empirically estimate a catastrophe insurance demand model in a least developed country setting. More specifically, we aim to identify the determinants of the household decision to protect themselves against disaster risks by participating in a hypothetical catastrophe insurance in a severely disaster prone country by testing standard economic principles and, empirical and experimental evidence outlined in literature. Using econometric models of the decision to participate in a hypothetical catastrophe

insurance programme to cover any losses from natural disasters, we find our results are highly consistent with both theory and available empirical evidence. The insurance purchase decision in our case study varies positively with households' exogenous and endogenous risk exposure level. Furthermore, our study demonstrates that education and occupation play an important role in determining catastrophe insurance demand. Novel in our study is the detection, through explicit and extensive testing, of the unambiguous negative impact of 'credit constraint' on insurance demand.

The paper is organized as follows: the next section reviews previous empirical studies related to the current research. We then present the model that explains the theoretical framework of our empirical work, followed by a description of the case study and survey design. Then the paper gives the statistical analysis results, and offers a conclusion and recommendation.

Literature Review

In the literature of risk and uncertainty, weather related risks are categorized as low probability high loss incidents (LPHL). LPHL events can be defined as risky situations where the probability of occurrence of the event is low, but the effect of the event may cause an enormous amount of loss (e.g., natural disasters, terrorism, and some environmental hazards). Standard expected utility theory predicts that all risk neutral or risk averse individuals would purchase insurance as long as the marginal benefit (i.e. marginal expected utility) from reduction of risk exposure level exceed the marginal costs (i.e. risk premium). However, the standard textbook theory fails to explain actual decision making in real situations in the case of LPHL events as buyers use ad hoc rules to assess the underlying risk and uncertainty associated with the occurrence of the event as

well as the credibility of risk mitigation instruments in question (Camerer and Kunreuther, 1989; Gine et al. 2007).

Although numerous studies have examined individual protection decisions against LPHL events in an experimental setting (e.g., Brookshire et al., 1985; Slovic, 1987; McDaniels, Kamlet and Fischer, 1992; Slovic, Fischhoff, and Lichtenstein, 1980; Camerer and Kunreuther, 1989; Kunreuther, 1996; Browne and Hoyt, 2000; Ganderton et al., 2000), empirical investigation of decision making rules over insurance demand in LPHL events is limited. Browne and Hoyt s' (2000) study is the most recent empirical study in a developed country context and the most remarkable among all. Browne and Hoyt (2000) estimate an insurance demand model for the subsidized National Flood Insurance Program (NFIP) in USA by using secondary data over 50 states for the period of 1983-1993. The results confirm relevance of some microeconomic principles with the decision making process of catastrophe insurance purchase. The authors find flood insurance demand positively related to income and negatively related to price (premiums per \$1,000). Household risk perception at the state level (as suggested by Kunreuther, 1984), instead of actual risk, is found to be an important determinant of insurance purchasing decision. The authors argue that households estimate probability of disaster event based on their experiences and hence is the reason that the number of flood insurance policies sold during a year is positively correlated with flood losses during the previous year.

Although some of the findings in Browne and Hoyt s' (2000) study are remarkable, especially the positive relationship between risk perception and insurance demand, the study fails to provide a comprehensive explanation of decision making rules in LPHL events mainly due to lack of

accurate data. Most importantly, the estimated demand model in Browne and Hoyt (2000) shows a significant positive relationship between the decision of insurance purchase and availability of government aid which is contrary to the proposition proposed by Lewis and Nickerson (1989). Lewis and Nickerson (1989) suggest that availability and access to ex-post public relief program (e.g., disaster loans, grants, etc.) work as a disincentive for consumers to invest personal resources on a protective action such as insurance. Furthermore, a number of other important questions remained unanswered by Browne and Hoyt (2000). For instance, in the absence of insurance, how individuals finance the flood losses (ex-post and/or ex-ante coping strategies?) and more importantly, how these coping strategies influence insurance purchasing decision?

Gine et al. (2007) investigate participation pattern for a highly subsidized rain-index based insurance program in a drought prone region of India. The explanations provided in this study for the low participation rate in an insurance program are different from the ones in the literature. The most stated reason among non-purchasers is that the consumers did not understand the insurance product, while slightly less than a quarter of the non-purchasers indicated income constraint as a reason for not buying the insurance scheme. Another quarter of the non-purchasers were skeptical about the insurance payout in the event of a disaster. Besides some theoretically expected explanatory variables like income fluctuation (i.e., expected damage) due to weather variation and household wealth, the explanatory variables that have been found to have strong influence on the decision rule of adopting mitigation action are credit constraint and familiarity with the insurance vendor. The study, furthermore, reveals that risk averse households are less likely to purchase insurance as a result of the uncertainty about the risk mitigation instrument that arises from their lack of experience with it.

The study by Gine et al. (2007) adds a new dimension to the 'LPHL events' literature. The most important contribution of the study is the detection that the decision making process of adopting mitigation action in a LPHL event depends –to some extent- on the socio-demographic context in which the decision is being made. This implies that in addition to conventional economic principles, social and behavioural theories are needed to explain some of the individual actions that are apparently inconsistent with economic theories. One of the most notable findings of the study is that the demand for insurance in developing country is constrained by consumers' lack of familiarity with the concept of 'insurance'. Furthermore, the relevance of credit constraint in confining the demand for weather insurance in relation to insufficient money income flow is well addressed and logically explained by the authors. However, the major drawback of the study is the authors' failure to explain the decision making process within the framework of environmental risk theory. More specifically, the study fails to take into account different dimensions of environmental risks and also is unable to confirm the theoretically expected relationship between environmental risks and household decision over mitigation action mainly because the study was limited to an area with almost no variation in exogenous risk exposure level.

This discussion from the literature on protective behaviour against LPHL events can be summarized into three key issues: 1) there exists a lack of common consensus among economists and social scientists about the construct of consumer preference in a LPHL events, 2) sets of explanatory variables that are broadly relevant in explaining mitigation actions against LPHL events widely differ in the developed and developing country context, 3) a comprehensive explanation of the decision making rule in a LPHL event, drawn from an empirical analysis is

still lacking. The current study aims to fill the gap in the literature and hopes to contribute by providing a more complete empirical demand model that combines both environmental risk theory and socio-demographic aspects of the decision making process.

Analytical Framework

Based on the discussions of the key findings from the existing literature, we construct the theoretical model of catastrophe insurance demand in the following form:

$$D_i = (R_i, A_i(Y_i, W_i, C_i), S_i) \dots\dots\dots \text{Eq(1)}$$

Equation (1) illustrates that the decision of an individual i to buy insurance against LPHL events (D_i) depends on (a) the level of risk exposure (R_i) (b) the ability to pay premium (A_i) which is determined by the flow of income (Y_i) or wealth (W_i) and, partly the availability and access to credit (C_i) (c) some relevant socio-economic and demographic characteristics (S_i) of the respondent.

We define risk, as suggested by Costanza (1994), as the probability (objective or subjective) of reaching a future state or outcome and the expected consequences of this state or outcome. According to conventional risk theory (e.g. Shogren and Crocker, 1991; Smith, 1992), risk exposure consists of an exogenous and endogenous component as people are - to some extent - able to protect themselves against (the negative impacts of) environmental risks, by avoiding the risk involved or by taking protective (preventive) measures before being exposed to the risk or afterwards (e.g. explicit or implicit insurance).

Following the seminal work by Knight (1921) and more recent expositions by, for example, Faber and Proops (1990) and Funtowicz and Ravetz (1992), we distinguish two different dimensions of exogenous risk exposure level: 1) the likelihood of being struck by disaster (probability of exposure) and 2) the consequence of risk exposure. The first dimension of exogenous risk, the probability of being exposed, furthermore can be measured from both objective and subjective perspective. We use objective probability (as suggested by Smith (1968)) of risk exposure level through i) return period of natural disasters in the past (respondents' past experiences with natural disaster) and ii) the distance (in kilometres) people live to the river at individual household level (the closer to the river, the higher the probability of getting affected). The consequence of risk exposure, the second dimension of exogenous risk exposure, is measured through economic damage cost (local currency converted to US\$) due to disaster at individual level.

We subsume the endogenous component of risk under adaptation and distinguish explicitly between ex ante and ex post adaptation mechanisms. Diversification of income sources is a well documented ex ante risk coping strategy in rural areas (Rosenzweig and Stark's 1989; Brouwer et al. 2007). In order to validate the use of 'income diversification' as an endogenous environmental risk exposure indicator (i.e., environmental risk coping mechanism) we use 'number of non-nature dependent income sources' as a measure of endogenous risk exposure component at the household level (the higher the number of non-nature dependent income sources, lower is the endogenous risk exposure level). Availability and access to ex-post disaster relief, as proposed by Lewis and Nickerson (1989), is used as a measure of ex-post endogenous risk exposure (higher the access to ex-post disaster relief, lower is the risk exposure level).

In addition to different measures of environmental risk and ability to pay, we hypothesize some socio-demographic variables to play a significant role in the decision making process. Among the wide range of socio-demographic variables, we consider education and occupation are the most relevant ones to explain household decision over mitigation behaviour. Gine et al. (2007) find that a large proportion of the non-insurance purchasers did not buy insurance simply because they did not understand what benefit the scheme was offering them or how buying insurance would help them to spread the risk of weather variability. Our hypothesis, in this specific case, is this that education enhances respondents' ability to understand the product even if they have very little prior experience with it. Therefore, we expect respondent's level of education to positively affect insurance demand. We, furthermore, acknowledge the validity of the idea introduced by Gine et al. (2007) that familiarity with the risk mitigation instrument is an important determinant of insurance demand. However, we assume that familiarity with the concept of insurance is largely determined by respondent's level of educational attainment.

Finally, we hypothesize that individual's preferences are likely to be heterogeneous towards risk reductions depending on the occupational cluster the individual belongs to. Different occupational groups suffer from varying degrees of damage as a result of the same disaster event. For instance, in general, disaster events are likely to cause more damage to farmers as opposed to fishermen or service holders. Therefore, the demand for mitigation action will partly depend upon the respondent's occupation.

The statistical model through which we aim to test our hypotheses takes the following form:

$$D_i = \beta_0 + \beta_1 R_Period_i + \beta_2 D_river_i + \beta_3 Damage_i + \beta_4 I_Sources_i + \beta_5 Relief_i + \beta_6 Income_i + \beta_7 Wealth_i + \beta_8 Credit_i + \beta_9 Occup_i + \beta_{10} Education_i$$

.....Eq (2)

For description of the variables and the expected signs of the coefficients see Table-1. Some of the explanatory variables included in the statistical model (Eq 2) are expected to have high correlation and therefore, it may not be possible to estimate the demand model including all the variables simultaneously. Particularly, we suspect the variables ‘Income’, ‘Wealth’ and ‘Damage’ to be highly positively correlated and therefore, we may need to exclude some of these variables from the model in order to avoid possible multicollinearity.

INSERT TABLE -1 HERE.

General Survey Design

The empirical investigation, undertaken by the current study, aims to test catastrophe insurance purchase decisions in a least developed rural economy setting. Since, an actual catastrophe insurance market in Bangladesh has not emerged yet, we lack actual insurance data which is required for empirical estimation purposes. Therefore, we construct a hypothetical market similar to a pre-product launch marketing survey where we ask the target group of clients whether or not they want to buy a hypothetically designed insurance product.

A preliminary short list of study sites was prepared after studying the available documents on history, trends and types of natural disaster in Bangladesh. For the selection of case study areas at

the final stage, we relied on information collected through a series of key informant interviews with the Director of Flood Forecasting and Warning Center at the Bangladesh Water Development Board, officials at Climate Change Cell in the Department of Environment, the Government of Bangladesh and policy planners in the Water Resource Planning Organization. Based on all available information and discussions with our key informants, we selected six districts from different parts of Bangladesh to carry out our empirical work. Four un-embanked riverine districts located near or at the two major rivers in Bangladesh (Meghna and Jamuna) were selected on the basis of damage intensity levels observed and monitored during the 2004 disaster flood. Furthermore, one district located inside the Ganges-Kobadak project (one of the oldest and biggest Flood Control and Irrigation Projects in the country)ⁱ and one coastal district (surrounded by the Bay of Bengal and lower Meghna) were selected for the study.

For spatial location of our study area see Figure 1.

INSERT FIGURE-1 HERE

From these six main districts we selected seven sub-districts (called ‘upazilla’) located close to the main rivers. Lower administrative units such as ‘district unions’ and ultimately individual villages were chosen from these sub-districts based on a random sampling. Approximately 120 interviews were conducted in four villages in each union. In total around 600 household heads were interviewed in each sub-district. The area-wise distribution of the sample is presented in Table 2. The selection of households in each of the villages followed a systematic random sampling method where every fifth household located along the right side of the main village road was interviewed. Only the heads of households were interviewed in this survey.

INSERT TABLE 2 HERE.

The questionnaire used in this case study was developed and finalized based on focus group discussions and pre-tests in each of the study areas. The questionnaire design started in June and lasted until August 2006. Around 3,000 household heads were interviewed during the final survey from the third week of August until the first week of October 2006 by 20 trained and experienced interviewers. The interviewers used for the general survey also participated in the pre-tests and were trained in a three day long training programme followed by several briefing and debriefing sessions until the commencement of the final survey.

The questionnaire used for the final survey consisted of around 50 questions and was divided into different sections. In the first section respondents were asked about their age, occupation, educational background, family size, sources of income, assets, standard of living and so forth. The second section comprised questions related to households' experience of catastrophic events where respondents were first asked whether or not they had suffer from climatic disasters. Those who replied positively were further asked how frequently they had been struck by catastrophic events, the nature and extent of damage they suffered and the type of ex-ante and/or ex-post disaster loss mitigation measures they adopted to prevent/protect themselves. The third section of the questionnaire introduced the respondent with a potential 'Catastrophe Insurance' that would effectively help to spread risk of damage caused by natural disasters. The respondents were offered the hypothetical 'Catastrophe Insurance' in the following form:

I would now like to ask you a number of questions related to the potential of introducing a natural disaster insurance scheme in this area. The principle of the proposed insurance scheme is as follows: you pay a fixed amount of money to secure possible damages of your house, crop, health or income for the next five years - an insurance premium - every week, two weeks or month depending on your preferred payment frequency. Only in the case of an officially acknowledged natural disaster, you will get compensated for any losses you suffered. If there is a disaster and you claim compensation, an independent surveyor will visit you and assess the extent of damage you suffered. Based on the

surveyor's independent assessment you will be compensated. The terms and conditions of your insurance scheme are protected by national law.

After a detailed description of the proposed insurance scheme, respondents were asked whether or not they would be willing to participate in such an insurance scheme in order to reduce the damage risk they were exposed to at that point in time. Respondents who replied positively were then subsequently asked in a follow-up question about the kind of insurance/s they would like to buy among four available options (house property, crop, health, unemployment), how frequently they would like to pay for their most preferred insurance scheme/s and who they would prefer as the provider of the insurance scheme (Government, micro-credit organizations, insurance companies, local co-operatives). On the other hand, respondents who did not agree to participate in the proposed catastrophe insurance scheme in principle were asked about reasons for not buying insurance in a follow-up question. The questionnaire suggested several reasons including; "I do not have sufficient income to pay premium", "I did not like the terms and conditions of the proposed insurance scheme"; "I am unable to assess the usefulness of the proposed insurance scheme at this moment"; "I do not believe that I will actually be compensated"; "Damage that occurs due to flooding is not an important issue for me" and "I find other things on which I can spend my money more important".

Sample Characteristics and Nature of Damage

Ninety nine per cent of the 3,000 household heads interviewed in our survey were men. Most (86%) were born and raised in the sub-district where they were interviewed. The average age of the respondents was 44 years, ranging between 30 to 75 years. About half of the respondents included in the survey were unable to read and write. Just over a quarter had finished primary

school and only 13 per cent finished high school. Each household consisted of six family members on average. Almost all households owned the house they lived in, and a majority of 58 per cent owned the land they grow their crops on. A tube well was the main source of drinking water for a majority (99%) of the households and only 17% of the households had a sanitary latrine in their dwelling. Around half of the sample households did not have an electricity connection in their house. The majority of the households use leaves, twigs and cow dung as their main source of energy.

Around half (47%) of the sample households were involved in agricultural activities while approximately 14 per cent of the sample population worked as agricultural day labourers. Trade (15%), transport (taxi, ferry) (4.5%), service (administrator) (6.5 %) and construction worker (3.2%) were the other livelihood options for the sample households. Average annual household income (related to the past 12 months) was about US\$ 960, while half of the sample population earned US\$ 683 per year. Dividing the median yearly income by the average household size and 12 months, average per capita income equaled US\$ 9.87 per month, which was substantially less than the national average rural per capita income (US\$ 14) (BBS, 2005). Using the poverty income definition of the Bangladesh Bureau of Statistics (poverty threshold value of US\$ 125 per capita per year), 51 per cent of the floodplain residents included in the sample appeared to live below this poverty threshold. According to HIES (Household Income and Expenditure Survey 2000), 49 per cent of the total population in Bangladesh lives below the upper poverty line. We hence conclude that our sample is representative in terms of household and per capita income levels.

Average household damage costs were US\$342 per household per catastrophic event. This amounted to approximately 35 per cent of average yearly household income. Median damage costs caused by natural disasters were US\$ 164. Dividing this by the median value for household income, the share of damage in household income was slightly lower, namely 24 per cent. The minimum damage costs were zero and the maximum US\$ 12,538. Trimming off the five per cent lowest and highest values, the average damage cost estimate was US\$ 251 per household per catastrophe event. The most damage was crop damage (67.2%), followed by damage to house property (51.7%). Other damage categories included income losses due to unemployment (32.5%) and fish pond damage (11.5%).

Empirical Results

As suspected, the consequences of risk exposure, measured through economic damage costs, are significantly positively correlated with both household's wealth ($r=0.554$; $p<0.01$) and average yearly income ($r=0.511$; $p<0.01$). This means that, on average and *ceteris paribus*, wealthier and high income households suffer from higher damage costs as a result of catastrophic events. Furthermore, household yearly average income level is positively correlated with the value of all tangible assets, i.e. wealth ($r=0.549$; $p<0.01$), suggesting that wealthier households have higher income flow which supports the fundamental stock-flow relationship. In view of the high positive correlation between 'Damage -Income', 'Damage-Wealth' and 'Income-Wealth', we choose only one variable and exclude the others from the statistical model we presented in Section 3 (Eq 2). As 'Damage' and 'Income' may influence other explanatory variables in the model too (i.g.

‘Income-Educ’ and ‘Damage-D_river’ and so forth), we choose to exclude both ‘Income’ and ‘Damage’.

A number of interesting issues evolved within the framework of a rural credit market when the sample population was asked about the nature and extent of their access to credit. First, we find a variation in our sample in terms of the institutional structures of credit market to which the respondents had access to (formal and informal). Second, we observe a variation in the sample in terms degree of accessibility in credit which was reflected through the number of credit sources an individual household has access to (e.g., micro credit institution, relative, friends, and village chairman). Therefore, an important question that arises in this context is that whether or not these variations in institutional framework and degree of accessibility in the credit market have any substantial role to play in determining catastrophe insurance demand. Therefore, in order to test this new issue, we created four different variables [Credit (any sort of credit), Credit_F (formal credit), Credit_I (informal credit) and Credit_S (number of sources)] to control for credit market characteristics in our sample.

Around half of the 3,000 households interviewed for this survey agreed to buy disaster insurance in principle (n=1530). Next we estimate a logit regression model of insurance participation in which the dependent variable takes a value of 1 if the household agrees to purchase the proposed insurance and 0 otherwise. The binary discrete choice dependent variable is then regressed on theoretically expected independent variables using a binary logistic regression model in STATA 9.1.

Table 3 presents results from four logistic regression models. The models differ mainly because we have used four different variables to control for credit market characteristics. All of the estimated models turned out to be significant at less than one per cent level (see Table 3 for likelihood ratio test) which implies that each of the models (as a whole) is significantly different from the one with constant only. The models have a predictive ability of 60 per cent on average. The Wald test statistics (commonly used to test significance of individual logistic regression coefficients) is significant at less than five per cent level for all the independent variables identified in the theoretical model in equation 2 (section 3).

INSERT TABLE-3 HERE.

In our estimated catastrophe insurance demand model, 'R_period' (return period of disaster events) has, as expected, a significant negative impact on insurance purchasing decision which implies the higher the number of years it takes for a natural disaster to occur, the lower the likelihood of taking mitigating action, all other factors being constant. The insurance participation decision, furthermore, has a significant negative relationship with the variable 'D_river' (distance of household dwelling from main river in Km) suggesting that the further away the household lives from the main river, the lower the exogenous risk exposure level and therefore, the respondent is less likely to buy catastrophe insurance.

Both 'Relief' (access to ex-post disaster relief) and 'I_sources' (number of non-nature dependent income sources) variables, used as indicators of endogenous risk exposure level, as expected, were significant at less than one per cent level with the expected sign of the coefficients. These

findings suggest that households which have access to ex-post disaster relief (informal insurance) and large number of non-nature dependent income sources (an implicit insurance) are less likely to participate in the formal insurance programme.

We used 'Wealth' as an indicator of household's ability to pay and as predicted by the expected utility theory, we find a positive relationship between wealth and insurance demand. This implies, other things remaining the same, a rise in asset value would increase the likelihood of household participation in the insurance programme. In view of the insufficient money income flow in a less developed rural economy, we tested the influence of different institutional frameworks of the credit market and the degree of accessibility in rural credit market (which we assume enhances household's ability to pay premium) on insurance demand. As expected, the credit variable, irrespective of the institutional framework, is positively related to the insurance demand suggesting that households that have access to credit (either only formal, only informal or both formal and informal) are more likely to participate in the insurance programme than those that do not. The degree of accessibility in the credit (measured through the number of credit sources households have access to), is positively related with the catastrophe insurance demand which implies, other things remaining the same, the high degree of accessibility in the credit increases the likelihood of buying insurance.

Finally, both the socio-demographic variables, 'Educ (education)' and 'Occup (occupation)', included in our demand estimation model, were statistically significant with the theoretically expected signs. As predicted, in a least developed country education positively influences the demand for a newly offered risk mitigation instrument such as insurance. We, furthermore, find a

positive correlation between education and insurance familiarity ($r=0.216$; $p<0.01$) which indicates respondents who at least had a high school equivalent education are more familiar with insurance. The coefficient of the variable 'Occup' is positive and highly statistically significant. This result supports our hypothesis that occupational differences among the target group do have a substantial impact on the demand for catastrophe insurance as damage cost incurred as a result of catastrophic events are not equally distributed among all occupational group.

Discussion and Conclusion

The aim of the study, presented in this paper, was to estimate demand model for catastrophe insurance in a disaster prone least developed economy. Building upon the growing theoretical and empirical evidence regarding consumer preference for protective action in a LPHL event, we produced a simple analytical model and tested the relationship between the model's core variables in a logistic regression model, using data and conventional indicators from a large-scale household survey in rural Bangladesh. Although a number of studies have been carried out investigating determinants of natural disaster insurance, such a systematic empirical examination that combines both environmental risk theory and socio-demographic aspects of the decision making process is currently lacking. The case study areas were selected from six districts in Bangladesh facing various exogenous risk exposure levels. Using econometric models of the decision to participate in a hypothetical catastrophe insurance programme to cover any losses from natural disasters, we find our results are highly consistent with both theory and available empirical evidence. Novel in our study is the exposition, through explicit and extensive testing, of the unambiguous negative impact of 'credit constraint' on insurance demand.

In our study, we explicitly distinguished between exogenous and endogenous risk exposure level. We used the disaster return period (subjective probability of getting struck by disaster event) and the distance of the household dwelling from the main river as indicators of the exogenous risk exposure level. Furthermore, the endogenous risk exposure level was measured through household access to ex-post disaster relief and the number of non-nature dependent income sources. Our results confirm a positive relationship between environmental risk (both exogenous and endogenous) and demand for mitigation action. We find that respondents who experience a higher disaster return period in the number of years (low exogenous risk exposure level) and households that are located further away from the main river (low exogenous risk) are less likely to buy insurance. On the other hand, as expected, we find households that have access to ex-post disaster relief and households that have a large number of non nature dependent income sources are less likely to buy catastrophe insurance.

Household wealth, as suggested by economic principles, is positively related with catastrophe insurance demand suggesting that wealthier households are more likely to take protective action against disaster losses than less well off households. Credit constraint also results in lower insurance demand, confirming the hypothesis found in recent literature that suggests higher access to credit increases the target clients' ability to pay insurance premium. We, furthermore, investigated the relationship between insurance demand and the rural credit market more extensively by controlling for institutional structure (formal and informal) of the credit sources and the household degree of accessibility to credit (measured through the number of credit sources households have access to). Our results show a positive relationship between credit and the likelihood of buying insurance irrespective of the institutional framework of the credit source

and support the hypothesis that the high degree of accessibility in credit increases the likelihood of participation in the insurance programme.

We find the socio-demographic variables, education and income, significantly influence the insurance participation rate. Respondents who have at least high school level education are more likely to participate in the insurance programme compared to respondents who are illiterate or have never been to high school. Education, indeed, plays an indirect role in stimulating insurance demand by enhancing target clients' understanding level about the concept of insurance. Finally, we find heterogeneity in insurance demand across different occupation group which was expected. We find agricultural farmers more interested in buying insurance compared to other occupational group.

In sum, we used this study to set out a methodology for estimating demand for mitigation actions in LPHL events. We propose, through the successful testing of our own empirical model, that decision making process over mitigation actions against LPHL events involves a wide range of factors. In addition to standard microeconomic theories, socio-demographic characteristics of the target clients need to be taken into consideration in order to understand the construct of consumer preference.

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Figure 1 Geographical Location of the Study Sites.

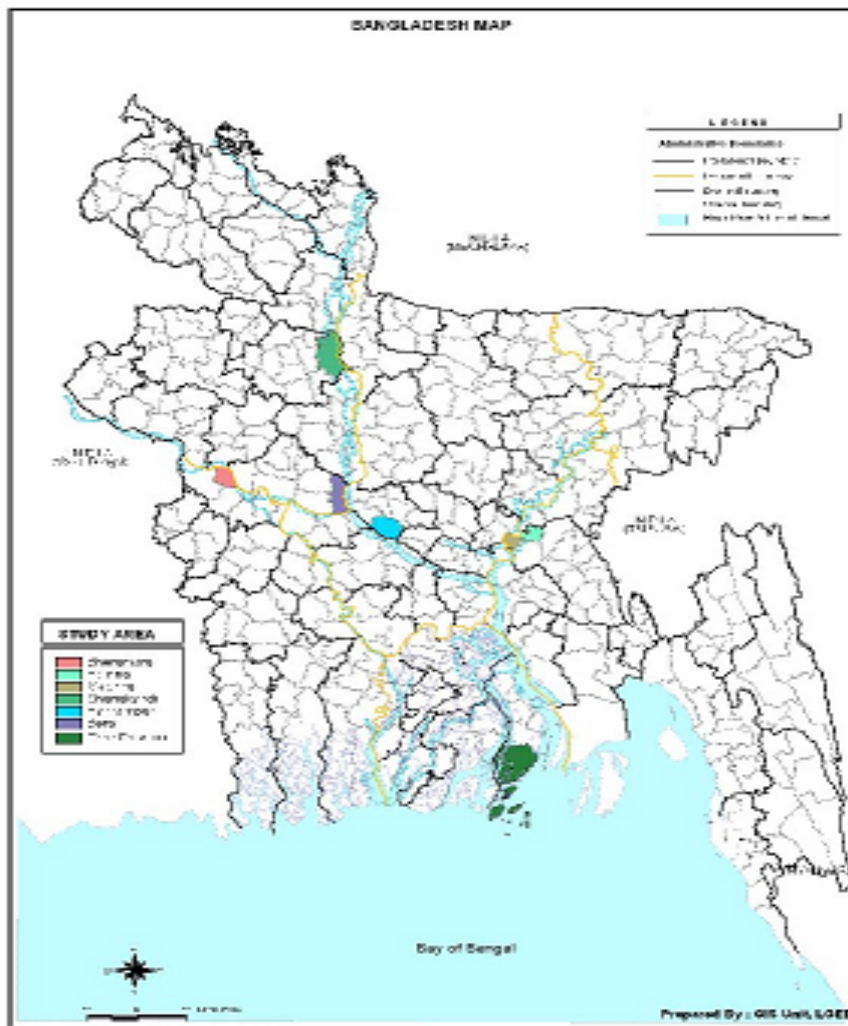


Table 1 **Hypotheses**

Variable	Definition	Hypothesized Sign
<i>Exogenous Risk Exposure Indicators</i>		
R_Period	Return period of disaster event in the past (once every -----year)	-
D_river	Distance of household's dwelling from the main river in Km	-
Damage	Total damage incurred during the last disaster event in monetary terms	+
<i>Endogenous Risk Exposure Indicators</i>		
I_Sources	Number of non-nature dependent income sources	-
Relief	Availability and access to post disaster relief	-
<i>Budget Constraint</i>		
Income	Average yearly income in '000 Tk.	+
Wealth	Market price of all tangible assets in '000 Tk.	+
Credit	Access to formal, informal credit and/or savings	+
<i>Socio-Demographic Characteristics</i>		
Occup	Respondent's occupation (farmer=1, Otherwise=0)	+
Education	Respondent's education (high school and above=1, otherwise=0)	+

Table 2 Distribution of sample across different districts with different risk types

District Name	Sub-District name	Types of natural disaster	Sample size
Comilla	Homna	Riverine Flood	361
Comilla	Meghna	Riverine Flood	240
Manikganj	Harirumpur	Riverine Flood	399
Bogra	Sariakandi	Riverine Flood	600
Pabna	Bera	Riverine Flood	200
Kushtia	Veramara	Water Logging	601
Bhola	Charfassion	Coastal Cyclone	603
	Total		3004

Table 3 Binary logistic regression results (Dependent Variable: participation=1, otherwise=0)

Variable Name	Description	Marginal Effects (at mean value of the explanatory variables)			
<i>Exogenous Risk Exposure Indicators</i>					
R_Period	Return period of disaster events	-0.0299*** (0.004)	-0.031*** (0.004)	-0.030*** (0.004)	-0.029*** (0.004)
D_River	River distance from the dwelling in Km	-0.0215*** (0.002)	-0.021*** (0.002)	-0.022*** (0.002)	-0.021*** (0.002)
<i>Endogenous Risk Exposure Indicators</i>					
Relief	Access to ex-post disaster relief=1, otherwise=0	-0.0537*** (0.016)	-0.054*** (0.016)	-0.056*** (0.016)	-0.055*** (0.016)
I_sources	Number of non-nature dependent income sources	-0.097*** (0.022)	-0.094*** (0.022)	-0.090*** (0.022)	-0.096*** (0.022)
<i>Ability to Pay</i>					
Wealth	Value of tangible assets in Tk.10,000	0.0003** (0.000)	0.0002* (0.000)	0.0002* (0.000)	0.0002** (0.000)
Credit	Household has access to credit=1, otherwise=0	0.083*** (0.020)	-	-	-
Credit_F	Household has access to formal credit only=1, otherwise=0	-	0.061*** (0.022)	-	-
Credit_I	Household has access to informal credit only=1, otherwise=0	-	-	0.043** (0.019)	-
Credit_S	Number of credit sources	-	-	-	0.052*** (0.013)
<i>Socio-demographic Characteristics</i>					
Educ	Respondent went to high school or above=1, otherwise=0	0.111*** (0.021)	0.108*** (0.021)	0.104*** (0.021)	0.109*** (0.021)
Occup	Farmer=1, otherwise=0	0.121*** (0.020)	0.128*** (0.020)	0.118*** (0.020)	0.123*** (0.020)
Constant		0.609*** (0.142)	0.79*** (0.127)	0.778*** (0.133)	0.649*** (0.138)
<i>Model Statistics</i>					
-2 Log Likelihood		3958.057	3966.474	3968.679	3958.966
Chi-square		204.809 (df=8, p<0.001)	196.39 (df=8, p<0.001)	194.18 (df=8, p<0.001)	203.900 (df=8, p<0.001)
Per centage correct predicted		60.8	59.8	60.1	61.0
N		3003	3004	3003	3003

ⁱ An embanked area was included as one of the study sites because of the high failure rate of flood protection embankments in Bangladesh to protect the residents from flood damage.