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Determinants of Participation in a Catastrophe Insurance Programme: Empirical Evidence from a Developing Country

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Abstract

The paper presents empirical evidence of the determinants of catastrophe insurance participation 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 in Bangladesh facing various environmental risk exposure levels about their willingness to participate in a catastrophe insurance programme. Combining factors put forward in risk theory and economics, we estimate a model of insurance participation. We show that the household decision to participate in the insurance programme differs depending on both exogenous and endogenous risk exposure levels. As predicted by micro-economic theory, ability to pay, measured in terms of household income and access to credit, significantly affects insurance participation. Furthermore, among the socio-demographic factors investigated in this case study, respondent education and occupation are found to significantly influence household decision making. Our study suggests that low participation rates for catastrophe insurance in a developing country can be explained by high rates of illiteracy and limited access to credit.

Key Words: Natural disasters, catastrophe, insurance, participation, risk, Bangladesh

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Introduction

Weather related risk is a major source of income fluctuations for rural households in Bangladesh. Both coastal as well as inland Bangladesh households face natural disaster risks 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. An important aim of the proposed disaster micro-insurance is to spread the risks of natural disasters, especially for the poor part of the population, in order to better prepare them to cope with increased climatic change 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, prepared by the Ministry of Environment and Forests (2005), 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 and spreading the risk of catastrophic events (Bouwer and Vellinga, 2002; Hoff et al., 2003; Mills, 2004), available evidence indicates that the participation in such insurance programmes is low throughout the world (Goes and Skees, 2003). The causes of under-insurance against natural disaster losses have gained substantial attention in the natural disaster and risk literature over the past 30 years (e.g. Cook and Graham, 1975; Kunruether, 1978, 1996; Shogren, 1990; Dong et al.,

1996; Arrow, 1996, Browne and Hoyt, 2000; Ganderton et al., 2000; Gine et al., forthcoming; Kriesel and Landry, 2004).

Kunreuther (1978) identifies a number of situations in which people fail to purchase insurance, even when it is available at low cost. According to the U.S. Senate Republican Policy Committee report, less than 30 per cent of vulnerable homeowners in the USA purchased insurance against flood peril despite the large number of explicit and implicit subsidies provided by the National Flood Insurance Programme (NFIP) (US Senate Republican Policy Committee, 2006). Empirical evidence of the success of mitigation actions and insurance programs against catastrophic events is even more spurious in developing countries. A case study by Gine et al. (forthcoming) shows that less than five per cent of the eligible farmers in a drought prone region in India buys rainfall insurance. The study furthermore reveals that the offered insurance scheme failed to attract the target group of farmers and the insurance was purchased mainly by those farmers who needed it least.

Given the unpredictable and inconsistent nature of consumer behaviour in the context of insurance participation against natural disasters, the current study aims to estimate an empirical model of catastrophe insurance participation in a developing country setting. More specifically, we aim to identify the core determinants of rural household decision-making to protect themself against natural disaster risks by participating in a hypothetical catastrophe insurance programme in a severely disaster prone country (Bangladesh). Our interest is specifically in the design of programs that have a greater participation rate. We therefore focus in this study particularly at identifying the socio-economic factors that influence the take-up of a catastrophe insurance program in rural Bangladesh. Although there are numerous relevant actuarial issues associated

with an insurance design involved as well (e.g. premium setting, adverse selection, moral hazard), they fall outside the scope of the current study. We are primarily interested in determining what makes rural households decide to participate on the outset of an insurance programme, without knowing the technical actuarial details of the specific insurance programme. Econometric modelling of the decision to participate in a hypothetical catastrophe insurance programme to cover losses from natural disasters, we find our results are consistent with both theory and the available empirical evidence. The insurance participation decision in our case study varies depending on a combination of exogenous and endogenous risks. Furthermore, our study demonstrates the importance of education and access to credit in catastrophe insurance participation. The influence of especially the latter factor (credit access and facilities) has not been researched before to our knowledge and provides a novel perspective in our study on the insurance participation decision.

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

Although numerous studies have examined individual protection decisions against catastrophic events in an experimental setting (e.g., Slovic et al., 1980; Brookshire et al., 1985; Slovic, 1987; Camerer and Kunreuther, 1989; McDaniels et al., 1992; Kunreuther, 1996; Ganderton et al., 2000), empirical investigation of decision making rules over catastrophic insurance participation

is limited. Browne and Hoyt (2000) estimate an insurance demand model for the subsidized NFIP in USA by using secondary data over 50 states for the period of 1983-1993. The results confirm the 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 risk premium. Household risk perception at the state level, instead of actual risk, is found to be an important determinant of the insurance purchasing decision. The authors argue that households estimate the probability of a disaster event based on their experiences and is hence the reason that the number of flood insurance policies sold during a year is positively correlated with flood losses during the previous year.

Some of the findings in Browne and Hoyt s' (2000) study are noteworthy, especially the positive relationship between risk perception and insurance demand. However, the estimated demand model in Browne and Hoyt (2000) shows a significant positive relationship between the decision of insurance purchase and the availability of government aid, which is contrary to the proposition by Lewis and Nickerson (1989). Lewis and Nickerson (1989) suggest that availability and access to ex-post public relief programmes (e.g., disaster loans, grants, etc.) work as a disincentive for consumers to invest personal resources in protective action such as insurance. A number of other important questions remain unanswered, such as how individuals finance flood losses in the absence of insurance, and how possible coping strategies (endogenous factors) influence the insurance purchasing decision.

Kriesel and Landry (2004) estimated a flood insurance participation model using individual household data collected through a mail survey in nine coastal counties in the US during the

period 1998-1999. The study shows a 49 per cent participation of eligible property owners in the NFIP. The study finds that the price of flood insurance (risk premium), respondent income, the mandatory insurance purchase requirements for mortgage borrowers, the distance from the erosion reference feature and return period of a hurricane are important determinants of insurance participation. Due to a lack of data, they are unable to test for the impact of disaster relief on insurance participation.

Gine et al. (forthcoming) investigate participation patterns for a rain-index based insurance programme in a drought prone region of India. The most stated reason among non-purchasers of the insurance is that they do not understand the insurance product, while insufficient income is an important reason for not buying the insurance scheme in less than a quarter of the cases. Another quarter of the non-purchasers are skeptical about the insurance payout in the event of a disaster. Besides theoretically expected explanatory variables like income fluctuation due to weather variation and household wealth, other explanatory variables that have a significant influence on the decision rule of adopting mitigation action are credit constraints and household 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.

An important contribution of the study by Gine et al. (forthcoming) is the finding that the decision-making process of participating in an insurance program depends – to some extent – on the socio-demographic context in which the decision is being made. One of the study's most notable findings is that the demand for insurance in a developing country is constrained by

consumers' lack of familiarity with the concept of 'insurance'. Furthermore, the relevance of credit constraint in confining participation in the insurance programme in relation to insufficient money income flow is well addressed and logically explained by the authors.

The discussion of the literature on protective behaviour against catastrophic events indicates that a variety of possible factors affect the participation rule in catastrophe insurance. Here, we aim to extend the existing empirical analysis and provide a more comprehensive participation model that combines risk theory and the socio-economic context of the decision-making process.

Analytical Framework

Standard expected utility theory predicts that all risk neutral or risk averse individuals will purchase insurance as long as the marginal benefit (i.e. marginal expected utility) from a reduction in the risk exposure level exceed the marginal costs (i.e. risk premium). Essentially, the price of insurance or risk premium is a key determinant of the individual's decision to purchase an insurance coverage (Smith, 1968). However, one of the many challenges encountered by researchers in estimating an insurance participation model is that data on the price of insurance (risk premium) are only observable for those individuals/households who participate in the program. Therefore, incorporation of the price of insurance in any empirical participation model becomes impractical, especially in situations where the risk premium is based on individual choice of the insurance's face value (maximum damage compensation receivable by the insured). One effective solution to this problem is to adopt a generated regressor approach, where predicted values of insurance price are used instead of actual prices (Kriesel and Landry, 2004).

However, application of such approaches requires detailed information about for example households' geographical location and land elevation, which may be difficult to obtain or only at very high cost. Furthermore, the statistical procedure is cumbersome and ineffective in situations where an actual insurance market is yet to emerge. As a result, empirical studies that focus on insurance participation decisions more generally often ignore insurance price (Blank and McDonald, 1996; Jütting, 2004; Ham and Sheppard, 2005; Mohammed and Ortmann, 2005; Trujillo, 2005). An additional argument to disregard risk premium in a generic insurance participation model is the empirical evidence of the price inelastic nature of catastrophe insurance demand. The estimated marginal effect of a $1 rise in risk premium on the probability of insurance demand ranges between -0.259 to -0.38 (GAO, 1983; Barnett and Skees, 1995; Browne and Hoyt, 2000; Kriesel and Landry, 2004), suggesting that although risk premium is expected to play a role in determining insurance participation, the weight attached to risk premium compared to other relevant variables is expected to be low.

Based on the discussion above and the key findings from the existing literature, we construct the following theoretical model for catastrophe insurance participation:

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

Equation (1) represents the decision of an individual i to participate in catastrophe insurance (D_i), which is expected to depend on the level of risk exposure (R_i), the ability to pay the insurance premium (A_i), which is determined by the flow of income (Y_i) and in part the access to and availability of credit (C_i), and relevant socio-economic and demographic household characteristics (Si).

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 themself against (the negative impacts of) environmental risks, by avoiding the risk involved or by taking protective measures before being exposed to the risk or afterwards. 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 between 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, can furthermore be measured from both an objective and subjective perspective. Here, we use the objective probability of risk exposure through i) the return period of natural disasters based on experiences in the past and ii) the distance (in kilometres) people live from the river (the closer to the river, the higher the probability of getting affected by flooding as one of the main environmental risks in Bangladesh). The consequence of risk exposure, the second dimension of exogenous risk exposure, is measured through the economic damage cost (local currency converted to US$) at individual household 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 (e.g. Rosenzweig and Stark's 1989; Brouwer et al. 2007). For this, we use the 'number of non-nature dependent income sources' as a measure of the endogenous risk exposure component (the higher the number of non-nature dependent income sources, the lower the expected endogenous risk exposure level). Although

partly exogenous at individual household level, availability and access to ex-post disaster relief, as proposed by Lewis and Nickerson (1989), is used as another proxy of ex-post endogenous risk exposure (the more access to ex-post disaster relief, the lower the risk exposure level).

Although no specific risk premium was offered to the respondents in our case study, the participation decision in the hypothetical insurance programme is expected to be positively influenced by respondents' ability to pay. Survey respondents were explicitly informed that the insurance scheme is not free of cost. We hypothesize that households' ability to pay is directly influenced by income and indirectly by access to micro-credit. Therefore, we expect both income and access to micro-credit to have a significant positive relationship with the insurance participation decision. This hypothesis is straightforward in the case of household income. From a household budget point of view, people with higher incomes are more able to pay a risk premium. However, the hypothesis about the existence of a positive relationship between access to micro-credit and insurance participation is debatable as access to credit is often documented as an ex-post disaster coping mechanism (Adger, 1999). The study by Gine et al. (forthcoming) detects a statistically significant positive relationship between access to credit and the insurance participation decision. Given the widespread evidence of micro-credit playing an important role in poverty eradication and income generation activities in Bangladesh (Khadaker et al., 1998; Khadaker, 2005), we view households' access to credit facilities as an indirect income enhancing factor in addition to an ex-post risk coping mechanism, and therefore expect access to credit to influence insurance participation in a positive way.

In addition to exogenous and endogenous environmental risk exposure levels and ability to pay, we hypothesize socio-demographic variables to play a significant role in the decision making process as well. Among the wide range of socio-demographic variables, we consider education and occupation the most relevant ones to explain household decisions over natural disaster mitigation behaviour. Gine et al. (forthcoming) 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 that education enhances respondents' ability to understand the product even if they have very little or no prior experience with it. Therefore, we expect respondent's level of education to positively affect insurance demand.

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 varying degrees of damage as a result of the same disaster event. For instance, disaster events are in general more likely to cause severe damage to farmers and fishermen, who are dependent for their livelihood on weather conditions, than professionals employed in public administration or the service sector. Therefore, insurance participation will partly also depend upon the person's occupation.

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

$$D_i = \beta_0 + \beta_1 R\_Period_i + \beta_2 D\_river_i + \beta_3 Damage_i + \beta_4 I\_Sources + \beta_5 \mathrm{R}elief + \beta_6 Income_i + \beta_7 Credit_i + \beta_8 Occup_i + \beta_9 Education_i$$

…….Eq (2)

For a description of the variables and the expected signs of the coefficients see Table-1.

INSERT TABLE -1 HERE.

General Survey Design

We selected the survey sites for our study based on the relative geographical distribution of different natural disaster risks in Bangladesh. Riverine flooding and coastal cyclones are the most common forms of natural disasters experienced by rural inhabitants of Bangladesh. Approximately 20 per cent of the country experiences regular annual flooding, while a catastrophic flood can inundate more than 50 per cent of the country's total area (Chowdhury, 2000). The country has a coastal zone that constitutes 32 per cent of the whole country, where28 per cent of the population lives and works (Islam, 2004). After devastating flooding in 1954 and 1955, embankments have been constructed around approximately 23 per cent of the total land area of Bangladesh as part of a structural water management program since the 1960s (Mirza and Ericksen, 1996).

Based on the above information and 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, we selected six districts from different parts of Bangladesh to carry out our empirical work. Four un-embanked riverine districts located near the two major rivers in Bangladesh (Meghna and Jamuna) were selected for our study on the basis of damage intensity levels 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)[1] and one coastal district (surrounded by the Bay of Bengal and lower Meghna) were selected. . The geographical locations of our study areas are presented in Figure 1.

INSERT FIGURE-1 HERE

From the six main districts we selected seven sub-districts 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 procedure. Approximately 120 interviews were conducted in four villages in each district 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 approach where every fifth household located along 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 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 pre-test debriefing sessions until the commencement of the final survey. The questionnaire used for the final survey

[1] 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 flooding.

consisted of around 50 questions and was divided into different sections. In the first section respondents are asked about their age, occupation, educational background, family size, sources of income, assets, standard of living and so forth. The second section comprises questions related to households' experience of catastrophic events where respondents are first asked whether or not they suffer from climatic disasters. Those who reply positively are further asked how frequently they have 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 adopt to protect themself.

The third section of the questionnaire introduces the respondent with a potential 'Catastrophe Insurance' that will effectively help to spread the risk of damage caused by natural disasters. Since an actual catastrophe insurance market in Bangladesh has not emerged yet, 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. 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 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 maximum amount of compensation you receive depends on the face value of your insurance. The terms and conditions of your insurance scheme are protected by national law.

After this description of the proposed insurance scheme, respondents are asked whether or not they would be willing to participate in such an insurance scheme in order to reduce the damage

risk they are exposed to at that point in time. Respondents who reply in a positive way are 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 prefer as the provider of the insurance scheme (Government, micro-credit organizations, insurance companies, local co-operatives). Respondents who do not agree to participate in the proposed catastrophe insurance scheme are asked for their reasons for not buying insurance in a follow-up question. The questionnaire suggests several reasons including "I do not have sufficient income to pay premium", "I do 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 the Natural Disaster Damage

Table 3 compares the general demographic and socio-economic characteristics of the 3,000 households included in our sample with the national population statistics. All household heads interviewed in our survey are men. Most (86%) are born and raised in the sub-district where they were interviewed. The average age of the respondents is 44 years, ranging between 30 and 75 years. About half of the respondents included in the survey is unable to read and write. Just over a quarter finished primary school and only 14 per cent finished high school. Each household consists, on average, of six family members. Almost all households owned the house they live in, and a majority of 58 per cent owns the land on which they grow their crops. A tube well is the

main source of drinking water for a majority (99%) of all households and only 17 per cent of the households has a sanitary latrine in their dwelling. Around half of the sample households does not have any electricity connection in their house. The majority of households uses leaves, twigs and cow dung as their main source of energy.

INSERT TABLE 3 HERE

Around half (47%) of the sample households are involved in agricultural farming as their main source of livelihood, while approximately 14 per cent of the sample population works as an agricultural day labourer. The remainder of the sample is employed in trade (15%), transportation (taxi, ferry) (4.5%), the service sector (administrator) (6.5 %) and in construction (3.2%). Average annual household income (related to the past 12 months) is about US$ 960, while half of the sample population earns US$ 683 per year. Dividing the median yearly income by the average household size and 12 months, average per capita income equals US$ 12.4 per month, which is slightly less than the national average rural per capita income (US$ 14) (BBS, 2005).

Average household damage costs due to natural disasters are US$342 per household per catastrophic event. This amounts to approximately 35 per cent of average yearly household income. Median damage costs caused by natural disasters are US$164. Dividing this by the median value for household income, the share of damage in household income is slightly lower, namely 24 per cent. The most important damage categories are crop damage (67.2%) and damage to house property (51.7%). Other damage categories include income losses due to unemployment (32.5%) and fish pond damage (11.5%). Average damage costs vary significantly across different occupational groups (Kruskal Wallis $\chi^2 = 472.141$; $p<0.001$). Figure 2 represents the distribution of average damage across occupational groups.

INSERT FIGURE 2 HERE.

Empirical Results

A number of interesting issues came up when examining the institutional framework of the rural credit market and the sample population is asked about the nature and extent of their access to credit. First, we find variation in our study in terms of the institutional structure of credit markets to which the respondents have access (formal and informal). Second, we observe variation in terms of the degree of accessibility in credit, reflected through the number of credit sources an individual household has access to (e.g., micro credit institution, relatives, friends, or the village chairman). In the context of this study, the question arises whether or not these observed variations in institutional framework and accessibility to the credit market play any role in insurance participation. In order to test this, we created four different variables [Credit (any sort of credit), Credit_F (formal credit), Credit_I (informal credit) and Credit_S (number of credit sources)] to control for credit market characteristics in our empirical model. Furthermore, we observe a high and statistically significant positive correlation between the consequence of risk exposure, i.e. economic damage costs, and average yearly household income ($r=0.511$; $p<0.01$). This means that, on average and *ceteris paribus*, high income households seem to suffer from higher damage costs as a result of catastrophic events. In view of the high positive correlation between 'Damage' and 'Income', we choose only one variable and exclude the other from the statistical model we presented in Section 3 (Eq 2). The summary statistics of the explanatory variables used in the statistical model are presented in Table 4.

INSERT TABLE 4 HERE

Around half of all the households interviewed agrees to participate in the proposed disaster insurance programme in principle (n=1530). Respondents who refuse to participate in the insurance scheme refer to 'limited financial income' (40%) and 'dislike of the terms and conditions of the proposed flood insurance scheme' (35%) as the two main reasons for not participating. Respondents denying to participate in the insurance scheme due to income constraints indeed earn significantly less income on average than groups who denied to participate for other reasons. Regarding the disliked terms and conditions, the most unpopular feature of the proposed insurance scheme is that the insured will not be given any monetary return in case of no disaster (mentioned by 65% of the respondents who stated 'dislike of terms and conditions' as their main reason for non-participation).

Next we estimated a binary logit regression model of insurance participation in which the dependent variable takes a value 1 if the household agrees to purchase the proposed insurance and 0 otherwise. The discrete choice dependent variable is regressed on the theoretically expected independent variables using STATA 9.1. Table 5 presents the results from four different model specifications. The models differ because we use four different variables to control for credit market characteristics. All of the estimated models turnout to be significant at less than the one per cent significance level as measured through the likelihood ratio test, which implies that the estimated parameters in each model are significantly different from zero (i.e. the model with a constant term only). On average, the models have a predictive power of 60 per cent. The individual parameter estimates associated with the independent variables identified in the statistical model in equation 2 (section 3) are all significant at the one per cent level based on the Wald test.

INSERT TABLE-5 HERE.

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

Both the variables 'Relief' (access to ex-post disaster relief) and 'I_sources' (the number of non-nature dependent income sources), used as proxies of endogenous risk exposure levels are, as expected, significant at the one per cent level with the coefficients showing the expected signs. These findings suggest that households who have access to ex-post disaster relief (implicit insurance) and have a large number of non-nature dependent income sources (a kind of informal insurance mechanism) are less likely to participate in the formal insurance programme.

We use 'income' as an indicator of the household's ability to pay and as predicted by economic theory, we find a positive relationship between income and insurance participation. This implies, other things remaining the same, that a rise in household income will increase the likelihood of household participation in the insurance programme. In view of the problems of insufficient

money income in less developed rural economies as in Bangladesh, we tested, as said, the influence of different institutional frameworks and the degree of accessibility to rural credit markets (which we assume enhances household's ability to pay an insurance premium) on insurance participation. As expected, the credit variable is positively related to insurance participation, irrespective of the institutional framework, suggesting that households who 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 who do not. Also accessibility to the credit market (measured through the number of credit sources households have access to) is positively related with catastrophe insurance participation, which implies, other things being equal, that a high degree of accessibility in the credit market increases the likelihood of buying insurance. In both cases we interpret this outcome as extending household ability to pay, not as an alternative ex post disaster coping mechanism, which would have resulted in a negative relationship.

Finally, the socio-demographic variables, 'Educ (education)' and 'Occup (occupation)' included in the participation model are statistically significant and have the expected signs. Education positively influences participation for a newly offered risk mitigation instrument such as insurance. We furthermore find a positive correlation between education and insurance familiarity ($r=0.216$; $p<0.001$), which indicates that higher educated respondents 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 within the target group of rural households affects the participation in catastrophe insurance due to the fact that the damage cost incurred as a result of catastrophic events is not equally distributed among all occupational group.

Discussion and Conclusion

The aim of the study presented in this paper is to estimate a participation model for catastrophe insurance in a disaster prone developing economy. Building upon the growing empirical evidence regarding catastrophe insurance participation, we presented a binary logistic model and tested the relationship between the probability of participation and the model's hypothesized core variables using data and indicators from a large-scale household survey in rural Bangladesh. Although a number of studies have been carried out investigating the determinants of natural disaster insurance participation, a systematic empirical examination that combines both risk and socio-demographic contextual factors underlying the decision-making process is lacking in the existing literature. The case study areas were selected from six districts in Bangladesh facing various environmental risks. Based on econometric modelling of the decision to participate in a hypothetical catastrophe insurance program to cover any losses from natural disasters, we find that our results are consistent with both theory and the available empirical evidence. Novel in our study is the examination of credit market characteristics in relation to insurance participation.

In our study, we explicitly distinguish between exogenous and endogenous risk exposure levels. The disaster return period (i.e. the probability of getting struck by a disaster event based on past experiences) and the distance a household dwelling is located from the main river are used as indicators of the exogenous risk component. The endogenous component of risk exposure is measured through the number of non-nature dependent income sources, and partly through household access to ex-post disaster relief. Our results confirm that as hypothesized there exists a positive relationship between environmental risk (both exogenous and endogenous) and

insurance program participation. Rural households who experience a higher disaster return (i.e. it takes longer before they are expected to be struck by the next disaster) and who are located further away from the main river (low exogenous risk levels) are less likely to buy insurance. Rural households who have a large number of non-nature dependent income sources and who have access to ex-post disaster relief are also less likely to buy catastrophe insurance.

Household income is positively related with catastrophe insurance participation, suggesting that well-off households are more likely to take protective action against disaster losses than less well off households. Credit constraints also result in lower insurance participation, confirming the hypothesis found recently in the literature which suggests that better access to credit increases the target clients' ability to pay insurance premium. We investigated the relationship between insurance participation and the rural credit market in more detail than previous studies by controlling for institutional structures and household accessibility to credit. Our results show a positive relationship between credit and the likelihood of participation in the insurance program, irrespective of the institutional framework of the credit sources or the degree of accessibility to credit program We argue that rather than considering micro-credit an effective alternative ex post disaster coping mechanism, negatively influencing the likelihood of insurance participation if it is viewed as a substitute for insurance, access to different types of formal and informal credit markets enlarges a household's ability to pay for insurance and hence increases the probability of insurance program participation.

Education also plays an important role in stimulating insurance participation by enhancing target clients' understanding of the proposed insurance market, where education level is positively

correlated with respondent understanding and familiarity with the concept of insurance. Respondents who have at least high school level education are more likely to participate in the insurance program compared to respondents who have never been to high school or are illiterate. We also find heterogeneity in insurance participation across different occupational groups, where farmers, who depend on weather conditions for their livelihood and are more exposed to natural disasters, are more interested in buying insurance than any other occupational group.

A number of important policy implications can be drawn from our study findings with respect to designing future micro-insurance programs to ensure higher participation rates. First, the result from our study indicates that households who have access to ex-post disaster relief are less likely to participate in an insurance program. In order to limit rural household reliance on ex post disaster government support and increase awareness, responsibility and accountability by forcing rural households to take self-protection measures, a policy option to increase participation rates in catastrophe insurance would be to reduce government expenditures on ex-post disaster relief and instead invest this in subsidizing catastrophe insurance programs. Second, the positive relationship between household access to credit and insurance participation suggests that micro-credit and micro-insurance are complementary products rather than substitutes. Therefore, extending and strengthening credit facilities in rural areas can play an important role in increasing the take-up of prospective insurance schemes. Finally, educated respondents are more familiar with the concept of insurance than respondents who are not well educated or illiterate. Given the high illiteracy rate in rural areas in Bangladesh, radio and television are important media in the short term to support efforts targeted at improving household understanding of the concept of insurance program. In the longer term, reducing illiteracy and improving education levels are

expected to be important poverty alleviation mechanisms, resulting simultaneously in an increase in ability to pay and increased awareness and understanding of the role of self-protection and insurance.

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Figure 1 **Geographical Location of the Study Sites.**

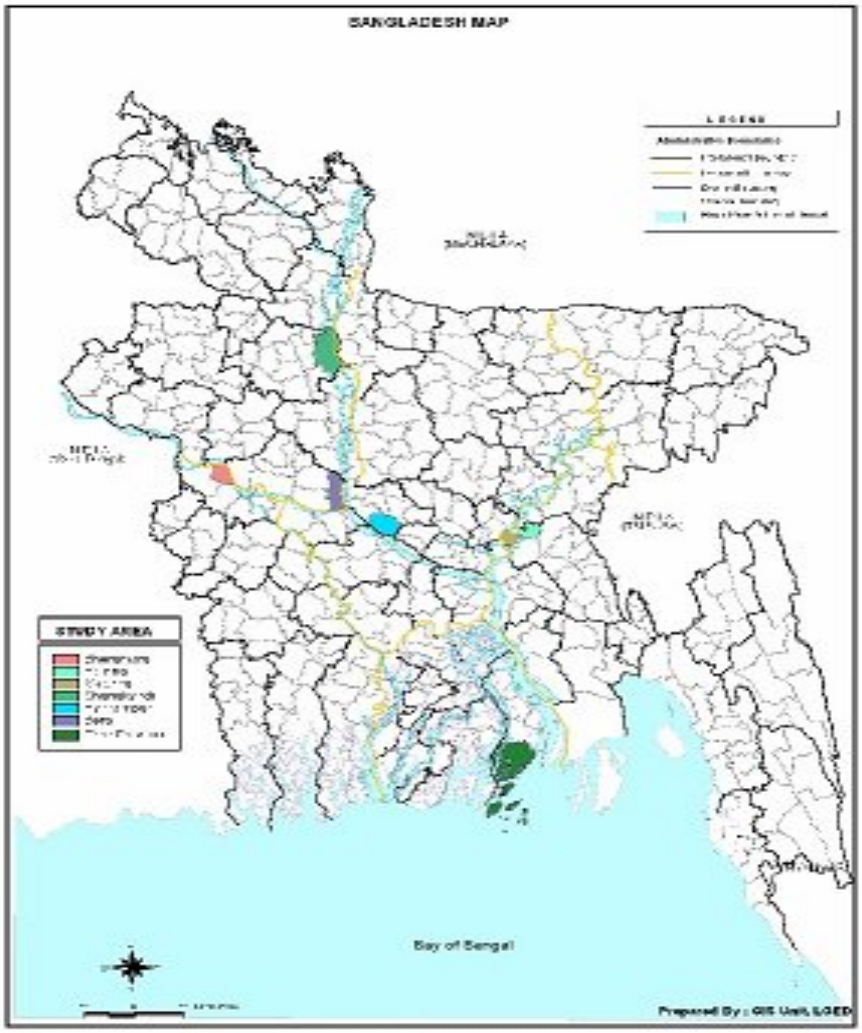

Figure 2 **Distribution of damage across different occupational groups.**

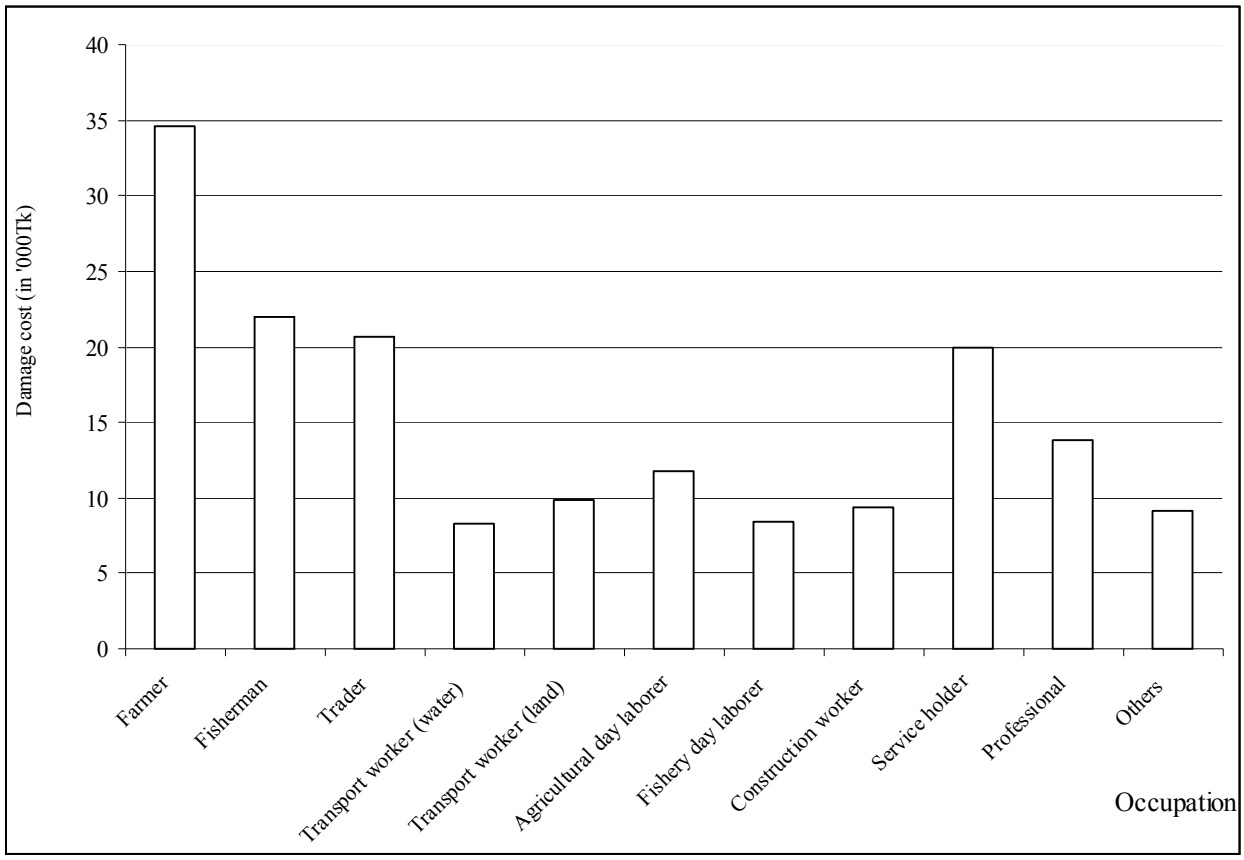

Table 1 **Hypotheses**

Variable	Definition	Hypothesized Sign
Exogenous Risk Exposure Indicators		
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	+
Endogenous Risk Exposure Indicators		
I_Sources	Number of non-nature dependent income sources	-
Relief	Availability and access to post disaster relief	-
Budget Constraint		
Income	Log of Average yearly income in '000 Tk.	+
Credit	Access to formal, informal credit	+
Socio-Demographic Characteristics		
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 **Summary statistics of respondent (household) demographic and socio-economic characteristics.**

Respondent (household) characteristic		**Sample**	**National average** (for rural areas)
Male headed household (%)		99	90
Respondent average age (median value)		44 (42)	42
Literacy rate respondent (%)	Illiterate	47.7	60.95
	Primary school	24.8	
	High school	14.0	
Respondent occupation (%)			
Agriculture, forestry and fishery		62.5	57.6
	Self-employed farmer	47.0	
	Self-employed fisherman	2.1	
	Day labourer	13.4	
Non-agricultural		29.2	41.3
	Trade	15.0	16.6
	Ferry/taxi worker	4.5	8.5
	Service	6.5	5.9
	Construction worker	3.2	3.19
Households with sanitary latrine facility (%)		17.3	20.59
Households with electricity connection (%)		45	31.19
Tube-well as main drinking water source (%)		98.8	95.75
Main sources of household energy (%)	Twigs/leaves/straw/dung	82.8	N/A
Average number of family members (min-max)		5.6 (1-26)	5.19
Average household income (US$/year) (st. dev.)		960 (1424)	1044
Median household income (US$/year)		683	
Average per capita income (US$/month) (st. dev.)		17.5 (20.3)	14
Median per capita income (US$/month)		12.4	
Households owning agricultural land (%)		58.4	65.60[a]
Average size land owned by household (ha)		0.74	
Average damage per household per disaster event (US$) (SD)		251 (550)	

a. National statistics considers farmers owning less than 0.5 hectare firm land as ‘landless’.

Source national statistics:

Household Income and Expenditure Survey, 2005, Bangladesh Bureau of Statistics; URL:

http://www.bbs.gov.bd/dataindex/hies_2005.pdf

Table 4 **Definition of variables and summary statistics**

Variable Name	Value	Description	Question in the survey	Mean	SD	Min	Max
R_Period	0 to ∞	Return period of disaster events	Do you suffer from disaster flooding/cyclones and if so, how often? 0=no, never 1=yes, once every …… years	4.49	2.34	0.33	15
D_River	0 to ∞	River distance from the dwelling in Km	How far is your house from the main river?	5.29	3.79	1.00	11.00
Relief	0,1	Access to ex-post disaster relief=1, otherwise=0	Did you ever receive any flood disaster relief?	0.24	0.43	0	1
I_sources	0 to ∞	Number of non-nature dependent income sources	What are the sources of your household income?	0.42	0.65	0	4
Income	0 to ∞	Natural log of yearly household income from all sources	How much income did your household generate over the past 12 months from different sources?	10.89	0.88	7.50	14.87
Credit	0,1	Household has access to credit=1, otherwise=0	Do you have access to credit facilities? If yes indicate the source/s from where you borrow money from?	0.25	0.43	0	1
Credit_F	0,1	Household has access to formal credit only=1, otherwise=0	Do you have access to credit facilities? If yes indicate the source/s from where you borrow money from?	0.51	0.50	0	1
Credit_I	0,1	Household has access to informal credit only=1, otherwise=0	Do you have access to credit facilities? If yes indicate the source/s from where you borrow money from?	0.64	0.48	0	1
Credit_S	0 to ∞	Number of credit sources	Do you have access to credit facilities? If yes indicate the source/s from where you borrow money from?	0.83	0.72	0	3
Educ	0, 1	Respondent went to high school or above=1, otherwise=0	Please indicate your level of education.	0.28	0.45	0.00	1
Occup		Farmer=1, otherwise=0	What is the main occupation of the head of household?	0.38	0.49	0.00	1

Table 5 **Binary logistic regression results (Dependent Variable: participation=1, otherwise=0)**

Variable Name	Description	Marginal Effects (at mean value of the explanatory variables)			
Exogenous Risk Exposure Indicators					
R_Period	Return period of disaster events	-0.034*** (0.004)	-0.032*** (0.004)	-0.032*** (0.004)	-0.031*** (0.004)
D_River	River distance from the dwelling in Km	-0.021*** (0.002)	-0.022*** (0.002)	-0.021*** (0.002)	-0.021*** (0.002)
Endogenous Risk Exposure Indicators					
Relief	Access to ex-post disaster relief=1, otherwise=0	-0.082*** (0.022)	-0.078*** (0.022)	-0.084*** (0.022)	-0.083*** (0.022)
I_sources	Number of non-nature dependent income sources	-0.066*** (0.016)	-0.069*** (0.016)	-0.067*** (0.016)	-0.069*** (0.016)
Ability to Pay					
Income	Natural log of yearly household income from all sources	0.057*** (0.011)	0.057*** (0.011)	0.066*** 0(0.012)	0.063** (0.012)
Credit_F	Household has access to formal credit only=1, otherwise=0	0.074*** (0.022)	-	-	-
Credit_I	Household has access to informal credit only=1, otherwise=0	-	0.053*** (0.019)	-	-
Credit	Household has access to credit=1, otherwise=0	-	-	0.100*** (0.021)	-
Credit_S	Number of credit sources	-	-	-	0.063*** (0.013)
Socio-demographic Characteristics					
Educ	Respondent went to high school or above=1, otherwise=0	0.098*** (0.021)	0.094*** (0.021)	0.102*** (0.021)	0.0998*** (0.021)
Occup	Farmer=1, otherwise=0	0.127*** (0.020)	0.1149*** (0.019)	0.120*** (0.019)	0.1217*** (0.019)
Model Statistics					
-2 Log Likelihood		3958.057	3966.474	3968.679	3958.966
Chi-square		215.88 (df=8, p< 0.001)	213.04 (df=8, p<0.001)	228.11 (df=8, p<0.001)	226.21 (df=8, p<0.001)
Per centage correct predicted		60.8	59.8	60.1	61.0
N		3003	3003	3003	3003