# FARMERS´ PREFERENCES FOR REDUCTIONS IN FLOOD RISK UNDER DIFFERENT PAYMENT MODES

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**ABSTRACT**

Uninsured agro-climatic disasters impose huge costs on farmers. Both insurance practitioners and academics are looking for alternative designs of insurance products to increase the purchase of insurance. This paper uses a split-sample choice experiment to investigate the effects of heterogeneous payment modes on purchase of insurance and preferences for flood risk reduction among farmers. Our findings do not support claims that *in-kind* insurance premiums increase insurance up-take. Furthermore, we estimate that farmers are willing to pay about 6.5 in labour hours, 20 kg in rice and 104 in GHS (US$27) for a one-year decrease in flooding frequency. The willingness-to-pay to increase insurance coverage by one 50 kg bag of rice is about 2 in labour hours, 4 kg in rice and 12 in GHS (US$ 3). These results indicate high preferences for reductions in agro-climatic risk and the only benefit of *in-kind* insurance premiums is their flexible payment options.

**KEYWORDS:** Flood insurance, *in-kind* premium, choice experiment, and random parameter error-components.

**JEL CODES:** C25, G22, O13, Q51, Q54

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[1] Godwin K. Vondolia acknowledges a travel grant from Terje and Valerie Stalder Jacobsens Foundation at the UiT- The Arctic University of Norway. In addition, we are grateful to Emmanuel K. Adadey and Seth Vondolia for facilitating the data collection in Ghana.

## 1. INTRODUCTION

The main purpose of the present study is to use a split sample discrete choice experiment to estimate and compare willingness-to-pay (WTP) for flood risk insurance when the insurance premiums are required in three different payment modes. Specifically, the paper examines how the demand for flood risk insurance varies under monetary and *in-kind* insurance premiums (i.e. labour working time and crop harvests). Affordability have been identified in several studies to be one of main reasons for the low demand for different formal insurance schemes (see e.g. Browne and Hoyt, 2000; Liu and Myers, 2014; Brouwer et al., 2014; etc.). In an attempt to ease this income constraint, an increasing number of insurance practitioners and academic literature are calling for social protection policies especially in developing countries to be more flexible and adopt better targeting mechanisms such as requiring insurance premiums in both monetary and *in-kind* (see Ahuja and Jutting, 2004; Bals et al., 2006; Oxfam America, 2012).

The inability to insure risks for shocks to employment, health, harvest, agro-climatic, etc. is one of the main channels for chronic poverty in the developing countries (see e.g. Jalan and Ravallion, 1999; Dercon, 2004a). Agriculture, for instance, is estimated to absorb about 22% of economic impact of medium and large-scale natural hazards and disasters in developing countries over the period of 2003 and 2013 (FAO, 2015). Agriculture remains a major economic sector in most developing countries and thus the economic costs of these disasters are huge. According to de Janvry et al. (2006), the uninsured risk contributes to poverty in both the short-run and in the long run. In the short run, households who face adverse uninsured shocks could not adopt strategies that will reduce the risk exposure and the consequences of the shock. With an inverse relationship between risk and return in the choice of economic activity, the uninsured risk leads to inefficiency in asset utilizations. In addition, if the ex-post risk coping instruments are ineffective, the uninsured risk could lead to excessive asset decapitalization with adverse consequences for human welfare. The long-term effects of uninsured risk include the longer time it takes households to recuperate assets that were decapitalized, under-investment in human capital, barriers on post-disaster economic transactions. In effect, uninsured risk causes inefficiency in both production and portfolio allocation decisions.

The expected increase in global temperature could expose farmers to further risks. For instance, with the changing global climate, farmers face new risks such as biophysical risks to production systems and higher uncertainties in production decisions. The fifth Assessment Report of Intergovernmental Panel on Climate Change (IPCC, 2014) establishes that extreme climatic events such as droughts, floods and vulnerability of natural and human ecosystems can be due to climate variability. It is in this direction that disaster risk preparedness and response receives national and international attention in climate change adaptation strategies (see e.g. MESTI, 2013). Internationally, the Hyogo Framework for Action (HFA) stipulates five priority actions and provides guiding principles and practical means for achieving disaster resilience including disaster risk reduction in agriculture (see Trujilo and Baa, 2014). Furthermore, the Hyogo Framework for Action identifies the development of financial risk transfer mechanisms including insurance to build resilience for post-disaster recovery. Furthermore, Di Falco et al. (2014) find that crop insurance reduces the extent of risk exposure and can serve as a climate adaptation strategy.

Although insurance provides mechanisms for risk transfer, the demand for insurance is low. A number of studies have attributed the low uptake of formal insurance to low income levels (see e.g. Browne and Hoyt, 2000; Giné et al., 2008; Liu and Myers, 2014; Brouwer et al., 2014). In response, different innovations and designs have been developed to overcome income constraints on the purchase of insurance for various shocks such as agro-climatic risks (see World Bank, 2005; Barnett and Mahul, 2007; World Bank, 2011). These include index-based insurance schemes, flexibility and better targeting of insurance programs, and government subsidies. Under the index-based insurance as compared to indemnity insurance, the payout is based on an objectively observable trigger. This is expected to reduce the insurance premiums since the verification of occurrence of shock is cheaper. In a review study, Alderman and Haque (2007) conclude that index-based insurance in several countries is still not reaching the low-income households, including smallholder farmers. The review suggests combining index insurance with access to savings, credit and cooperative marketing arrangements to expand provision. Furthermore, government subsidization of insurance against adverse climatic changes may lead individual decisions that increase susceptibility of people, property and economic activities to those risks (Mcleman and Smit, 2006). Another measure proposed to overcome the limitations that low-income levels place on demand for insurance is to design insurance schemes to be flexible in charging insurance premiums. This flexibility can take varying forms such as delays in the payment of premium until income is realized (Liu and Myers, 2014). Another proposal which shows great promise is requiring the insurance premiums in both monetary and *in-kind* resources such as labour time and commodities (Ahuja and Jutting, 2004; Bals et al., 2006; Oxfam America, 2012).

For instance, the Horn of Africa Risk Transfer Adaptation (HARITA), developed by Oxfam America, Swiss Re, International Research Institute for Climate and Society and Relief Society of Tigray with funding from Rockefeller Foundation and Swiss Re requires an *in-kind* insurance premium that is geared towards risk reduction and soil conservation (see Oxfam America, 2012). The HARITA is an integrated risk management framework, which combines risk reduction, risk transfer and micro-credit. . One main innovation of the HARITA program is the "insurance-for-work" model, which permit farmers to exchange labour for the purchase of insurance by engaging in activities to reduce risk such irrigation and soil conservation management (Oxfam America, 2012). The program has shown great promise at the initial stages. The HARITA program has extended insurance from 200 farmers in 2009 to 13,000 households in 43 villages within 2 years. The success of HARITA has led Oxfam America to collaborate with United Nations World Food Programme to expand HARITA to four countries under the R4 Rural Resilience Initiative (Oxfam America, 2012). In addition, evidence from randomized controlled trials on other insurance designs also indicate that innovative rainfall insurance in India induces farmers to shift production towards higher-return cash crops (Cole et al., 2014) and higher agricultural investments in Ghana (Karlan et al., 2014).

The present study uses a split-sample discrete choice experiment to compare the purchase of flood insurance under three alternative payment modes for paying insurance premiums; and estimate WTP for flood risk reductions among mechanized smallholder farmers in Ghana. The main findings are that *in-kind* insurance premiums do not appear to substantially increase the purchase of flood risk insurance indicating that real welfare improvements of in-kind premiums may be their flexible payment options. The WTP for a one-year decrease in frequency of flooding is estimated to be 6.5 in labour hours, 20 kg in rice and 104 in GHS (US$27). Farmers are willing to contribute about 2 hours in labour time, 4 kg in rice and 12 in GHS (US$3) to increase insurance coverage by one 50 kg bag of rice. These high WTPs indicate a widespread preference for in agro-climatic risk reductions among smallholder farmers in West Africa. This paper is an important contribution to previous studies that use stated preference methods to analyse the demand for insurance (Brouwer et al., 2013; Brouwer and Akter, 2010; etc.) by evaluating three alternative payment modes for paying the insurance premiums in discrete choice experiment. The rest of the paper is structured as follows. The theoretical and econometric framework for the estimation of welfare measures under different payment modes are discussed in the next section. The third section describes the study area and the discrete choice experimental design. The results of the study are presented in section four and the conclusions of the paper in the last section.

## 2.0 MATERIALS AND METHODS

### 2.1 Theoretical and econometric framework

The notion that the numeraire could affect the allocation of resources for both private and public is not new. In recent times, Brekke (1997) revisits the effects of numeraire on public resource allocation within the cost-benefit analysis framework mostly used for appraising environmental policies, projects and programmes. Specifically, Brekke (1997) notes that the numeraire in which the purchase of private goods such as flood insurance are required should not matter but should be relevant for public goods provision. This is because with private goods, the marginal rate of substitution between two private goods should be equal for different individuals. Dreze (1998) clarifies the conditions under which the marginal rate of substitution between two private goods may differ between individuals. These conditions are when one of the commodities is rationed, or the market for one of the commodities is segmented. In stated preferences, numeraires can induce heterogeneity in economic behavior through constraint heterogeneity. Constraint heterogeneity refers to the different non-trivial effects through which the choices of respondents depends on context e.g. the use of different numeraires (or constraints) for non-market environmental decisions (Phaneuf, 2013). Specifically, Rai and Scarborough, 2015) provides evidence that using monetary values to estimate WTP values disproportionately excludes the concerns of some community members. In their sample, only 35% elected to complete the choice experiment in monetary terms whilst 65% chose to complete the choice experiment in labour contributions. Furthermore, Brouwer et al. (2008) show in a follow-up survey those respondents who provide zero monetary bids can provide positive non-monetary bids. Furthermore, Asquith et al. (2008) find that respondents prefer non-monetary payments in exchange for environmental services; and O’Garra (2009) suggests that the respondents with lexicographic preferences may find non-monetary exchanges such as time for environmental goods and services to more acceptable relative to the exchange of environmental goods and services for money.

The behavioural foundations of the effects of using different numeraires have been investigated using stated preferences and formal experimental settings. Examples of these stated preference studies are Hess et al. (2012) and Gyrd-Hansen and Skjoldborg (2008), whereas experimental investigations into the effects of different payment modes are presented in Heyman and Ariely (2004), Ellingsen and Johannson (2009), and Lee et al. (2015). Using choice experiments, Gyrd-Hansen and Skjoldborg (2008) disentangle the impact of the payment vehicle per se from the price effects in choice experiment while Hess et al. (2012) assess the consistency and fungibility (i.e. interchangeability) of monetary valuations. Lee et al. (2015) investigates the processing of money and time in economic transactions. According to Lee et al. (2012) as money is the most common instrument of exchange, the use of money in transactions requires value considerations and invokes greater analytical thinking whereas time considerations in transactions are experienced or affective in nature. This is argued to affect consistency of human preferences.

Theoretically, choices are constrained by multiple resources, which makes it possible to elicit human preferences in multiple resources (Larson et al., 2004; Eom and Larson, 2006). This implies that the preferences for flood risk insurance can be elicited in any economic resource provided the resource constrains the purchase of flood risk insurance. Using money as numeraire, the preferences for flood risk insurance can be derived as:

$$V_m\left(y - WTP_m, \mathbf{p}_m, q_1; Z\right) = V_m\left(y, \mathbf{p}_m, q_0; Z\right) \tag{1}$$

where $V_m(\bullet)$ is the indirect utility function; $y$ is the income; $q_0$ is the status quo of no flood risk insurance; $q_1$ is the improved state of flood risk insurance; $WTP_m$ is the willingness to pay for the flood risk insurance, which is elicited in monetary units; $\mathbf{p}_m$ is the vector of prices;

and $Z$ denotes socioeconomic variables. Following Eom and Larson (2006), Vondolia et al. (2014) and Gibson et al. (2016), the WTP for flood risk insurance in labour units is derived as:

$$V_l\left(l - WTP_l, \mathbf{p}_l, q_1; Z\right) = V_l\left(l, \mathbf{p}_l, q_0; Z\right) \tag{2}$$

where $V_l(\bullet)$ is the indirect utility function; $WTP_l$ is the willingness to pay for the flood risk insurance, which in this instance is elicited in labor units; $l$ is the full budget stated in labour units; $\mathbf{p}_l$ is the vector of full prices in labour units; and other notations as stated earlier. Furthermore, we can infer from Shyamsundar and Kramer (1996) and Brouwer et al. (2008) that WTP for flood risk insurance elicited in rice is given as:

$$V_r\left(r - WTP_r, \mathbf{p}_r, q_1; Z\right) = V_r\left(r, \mathbf{p}_r, q_0; Z\right) \tag{3}$$

where $V_r(\bullet)$ is the indirect utility function; $WTP_r$ is the willingness to pay for the flood risk insurance, which is elicited in rice yield; $r$ is the full budget stated in rice yield; $\mathbf{p}_r$ is the vector of full prices in rice yield; and other notations as stated earlier.

To elicit preferences for attributes of flood risk reduction, we used stated preferences method of discrete choice experiment (DCE). The DCE is based on a new consumer theory (Lancaster, 1971) which postulate that utility is derived from attributes rather than goods themselves. In DCEs, respondents face a number of choice tasks. The choice set consists of more than one alternative, which are defined by attributes and attribute levels. The respondents then choose their preferred alternative in each choice task. The choices in DCE are hypothetical in nature, however, Vossler et al. (2012) present evidence that economic incentives are preserved in these hypothetical choices. Following Brouwer et al. (2013) who analyse the demand for flood risk insurance in Vietnam, we adopt random-parameter error component specification of the utility function for flood risk insurance. The random parameter error components model allows for inter-alternative correlation between alternatives. According to Train (2002), the random parameter model can theoretically approximate any random utility model (RUM). The random parameter specification of error components model allows the utility function to combine both the random parameter and error component and this breaks away independence of irrelevant alternative (IIA) and addresses unobserved heterogeneity (Scarpa et al., 2005). The purchase of insurance provides changes in the utility that could be different from the status of not buying the insurance.

We specify the utility structure for the random-parameter error component model is by:

$$U_{njt} = asc_j + \alpha x_{njt} + \varepsilon_j + u_{njt} \quad (4)$$

where $U_{njt}$ a refer to utility a farmer, $n$, derives from alternative $j$ on choice occasion $t$, $\alpha$ refers to the parameters (i.e. means and standard deviations) corresponding to different insurance attributes , $x$, $u$ are the unobserved utility components which are assumed to be independently and identically type I extreme value distributed (Gumbel). ). The error component, $\varepsilon$, is distributed $N\left(0, \sigma^2\right)$. Specifying the error components for all alternatives in the choice set leads to over-identification of the model. Therefore, we normalize the smallest variance component to zero (see Walker, 2007).

With a panel of $T$ discrete choices for each respondent $n$, the joint probability of sequence of T choices $\left\{y_1, y_2, y_3, ..., y_T\right\}$ by an individual is given by:

$$P\left(y_1, y_2, ..., y_T\right) = \int_\alpha \int_\varepsilon \prod_{t=1}^{T} \frac{\exp\left(\alpha x_{njt} + \varepsilon_j\right)}{\sum_{i=1,2,3} \exp\left(\alpha x_{nit} + \varepsilon_i\right)} \varphi\left(\varepsilon \mid \sigma^2\right) f\left(\alpha \mid \theta\right) d\varepsilon d\alpha \quad (5)$$

Note that the integral from equation (5) does not have closed-form. However, it can be simulated by averaging over a number of draws from assumed distribution (Revelt and Train, 1998). In our case, we approximate the simulated log-likelihood function by numerical simulation using 1000 halton draws.

## 2.2 Study area and the design of choice experiments

Irrigation is widely seen as a strategy for reducing poverty and improving food security in the developing countries (Burney and Naylor, 2012; Burney et al., 2013; World Bank, 2007). With only about 4 percent of total land in the region is irrigated (World Bank 2007) and poor maintenance existing irrigation infrastructure, prolonged rainfalls can easily cause flood and damage crops and property in Sub-Saharan Africa. The present study was conducted at Wheta/Afife Irrigation Scheme (WIS) located within the Volta River Basin in Ghana. Together with Dawhenya Irrigation Scheme and Asutsuare Irrigation Scheme, WIS is one of the main rice growing schemes in Ghana (Day and Acheampong, 1996). The initial dam was constructed in the 1960s and the capacity was expanded by the construction of the second dam in 1980s to irrigate plots for rice production. It has potential for about 950 ha, but 880 ha was developed and irrigated (see Mul et al., 2015; Amanor, 2015). Currently, the Ghana Irrigation Development Authority manages all irrigation schemes including WIS.

Devolution is a common mandate for managing common-pool resources. Under devolution, resource users are required to make monetary and non-monetary sacrifices to support participatory resource management. Since 1980s, devolution is an integral part of structural adjustment programme in Ghana and widely adopted at the Ministry of Food and Agriculture (Ofori 2000). Currently, farmers at WIS adopt different measures to mobilize resources for maintaining irrigation infrastructure including mobilization of monetary and non-monetary resources. However, the canals have not been properly maintained and this can be seen the increased siltation of irrigation canals. Floods destroy crops regularly (see the next section). Labour is a costly factor of production (Agbanyo, 2012) as it takes significant component of cost of production. As a result, the farming system at WIS is highly mechanized in that farmers adopt labour-saving technologies such as tractors and harvesters to reduce the production cost.

Data is not readable available for the estimation of demand for flood risk insurance in developing countries (see Cummins and Mahul, 2009). We therefore elicited preferences for flood insurance using hypothetical choices of farmers in a choice experiment. Preliminary surveys for the choice experiment were conducted in July 2015 during which focus group discussions were held among farmers; with additional discussions were also held with the management of the WIS on agro-climatic shocks to irrigation farming in the case study area. Flood risk was identified to relevant since the construction of dam for irrigation reduced the impact of drought on rice production in the area. The pilot study and the main data collection were conducted from November 2015 to February 2016. Different payment options for maintaining irrigation infrastructure have been implemented at the WIS (see Vondolia et al., 2014). This may have been the outcome of the structural adjustment program during which the project management was required to recover user fees from farmers to pay for the costs of pumping water under irrigation (Amanor, 2015). Furthermore, although majority of respondents indicated enrolling in the National Health Insurance Schemes, the up-take of disaster insurance/flood insurance is completely non-existent (see section four for details).

The survey was conducted as face-to-face interviews, since other survey administrations modes (e.g. phone, internet and mail, etc.) were not possible (see Durand-Morat et al., 2016). The respondents were recruited randomly from communities surrounding WIS during field visits. In all, we interviewed 398 irrigation farmers: 132, 133 and 133 respondents were interviewed with the labour, rice and monetary payment modes, respectively. Each respondent made 12 hypothetical choices under each payment mode. Efficient designs with zero priors were used for the pilot survey. Parameter estimates using the results from the pilot survey were used as priors to generate efficient design for the multinomial logit model (MNL) model in the main survey. Efficient designs for the MNL model can suffice for the estimation of panel mixed logit model (Bliemer and Rose, 2010). The design was created using Ngene (ChoiceMetrics, 2014).

The attributes and the attributes levels are presented in Table 1. Five attributes were used for each of the modes for the payment of the insurance premium. The selection of attributes was based focus group discussions among the farmers and from the existing literature particularly Brouwer et al. (2013). The attributes are (see also Vondolia and Navrud, 2017):

a) Flood occurrence - this refers to the number of years it will take for a flood incidence to recur. This attribute measures different degrees of flood frequency in the choice experiment. The attribute levels for flood occurrence 6, 8 and 10 years. The natural cycle for the occurrence of El Nino and El Nina (see e.g. Cai et al., 2014). In addition, Brouwer et al. (2008) notes that in a flood prone Bangladesh, the flood return period is between five to ten years.
b) Insurance coverage – this is the number of 50 kg bags of rice that the insurance company will pay in compensation if flood occurs. The insurance coverage has three level of 12 bags, 21 bags and 30 bags.
c) Probability of damage – this refers to the probability that the farmer is affected by the flood; and this is presented as an approximate number of farmers affected by flood out of every 6 farmers. The three levels identified are two (2) in about every 6 farmers, three (3) in about every 6 farmers and four (4) in about every 6 farmers. These levels were informed by discussions with extension officers that 5 out of the 11 sections are flood prone.
d) Insurance premium – this refers to the cost of purchasing the flood risk insurance per ha. As noted above, the insurance premium was stated in money (in Ghana Cedis, GHS), rice (number of 50 kg bags) and in labour working hours. Each of these modes of insurance premium has three identical levels of 150 GHS[2] (≈ 15 hours ≈ 2 (50kg) bags

[2] The exchange was 1 GHS = 0.26 US dollars. The price level ratio of PPP conversion factor (GDP) to market exchange rate in 2015 was 0.33 (World Bank,

of rice), 300 GHS (≈ 30 hours ≈ 4 (50 kg) bags of rice) and 450 GHS (≈ 45 hours ≈ 6 (50 kg) bags of rice) per ha. The market exchange rates were used in the conversion, and the exchanges rates were pretested in the pilot surveys as well.

Farmers are likely to have different plot sizes and this may affect the purchase of insurance in the DCE. As such, we introduce plot size as an additional attribute to fix the context for the purchase of flood insurance. The plot size also has three levels of 1, 2, and 3 ha.

An increase in risk exposure (i.e. a fall in flood occurrence and an increase in the probability of incurring damage) is expected to lead to an increase in the demand for insurance. Furthermore, it is expected coverage will increase the purchase of insurance whilst premium in all its forms will have negative effect on the demand for insurance. Finally, we expect that for farmers that are more likely to be risk-averse, the coefficient for plot size should be negative. A sample of the choice cards shown in each of the modes for paying insurance premium are presented in Figures 1, 2 and 3.

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http://data.worldbank.org/indicator/PA.NUS.PPPC.RF?end=2015&start=2014).This means that one requires 0.33 US dollars to buy one US dollar worth of goods in Ghana around the time of the survey.

**>>>>>>>>>>>Insert Table 1 about here<<<<<<<<<<<<**

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**>>>>>>>>>>>Insert Figure 3 about here<<<<<<<<<<<<**

## 3. RESULTS

We present the analyses of the results from the survey in this section. We begin the analyses of the results by first discussing the descriptive statistics of the sample. This is followed by the discussions of the estimated results and the willingness to pay estimates under the three modes of insurance premium.

### *3.1: Descriptive statistics*

The descriptive statistics of the three sub-samples are presented in Table 2. In this table, we also present whether the descriptive statistics are significantly different among the three modes for paying the insurance premium. The socio-economic characteristics of the sample indicate that about 34% of the respondents are female. The average age of the sample is about 48 years. On the average, farmers at WIS have been farming for about 24 years. In addition, low proportions of farmers (about 17%) indicate secondary school education and above. In total, each farmer has on the average has about 4 ha in rice farming. Average output is about 1 MT per ha. Further, most of the farmers have registered under the National Health Insurance Scheme (NHIS). About 62% of the respondents indicate that they have purchased NHIS. Based on this, we can deduce that the respondents have fair knowledge about how insurance schemes work.

The incidence of flood is high at WIS. On a 1 to 6 scale with 1 indicating “not important all” and 6 indicating “very important”, the average Likert score is 5.37. A high incidence of flooding appear more destructive to the farmers relative to other natural disasters. On the average, farmers experience flood every other year. The seriousness of the flooding is further shown by the perceptions on flood trends and durations. More than 70% of the farmers perceive the flood trend and duration to be increasing. The highest number of farmers experience their most recent flood in the year 2015. Specifically, more than 75% of the farmers suffer flood damage within previous 2 years. However, the highest number of farmers recorded the severest flood in the year 2006. Furthermore, the farmers think that flood is likely to recur within the next five years. In addition, the chances of flood affecting the farmers within the next five years is high.

Responses from farmers indicate severe credit constraints as can be seen from the high score for lack of credit opportunities. Similarly, poor infrastructure is a common problem in the communities in which the farmers live. These may be indications of severe market imperfections among the communities surrounding the WIS. Apart from output per ha and plot size, farmers interviewed under the three insurance payment options are identical.

**>>>>>>>>>>Insert Table 2 about here<<<<<<<<<<<**

**>>>>>>>>>>Insert Figure 4 about here<<<<<<<<<<<**

**>>>>>>>>>>Insert Figure 5 about here<<<<<<<<<<<**

The alternatives chosen are distributed quite equally among the three alternatives of one status quo (SQ) alternative of no insurance and two alternatives that were indicate the purchase of insurance. Figure 4 compares proportions of farmers who chose the SQ alternative under the three payment options. Specifically, Figure 4 presents a stacked bar chart of the proportions of respondents who choose the status quo of not purchasing flood insurance for all choice occasions under the three payment modes. The status quo alternative under the monetary insurance premium registers the lowest percentage of 28.62% and alternative A under rice insurance premium option records the highest percentage of 38.57%. In most CV studies that compare monetary versus non-monetary payments, the probability of accepting the scenario is higher under the non-monetary payments than under the monetary payments (see Vondolia, et al. 2014). This discrepancy in accepting the SQ disappears in the choice experiment. One plausible explanation could be that avoidance of 'yea-saying' problem in choice experiments (see e.g. Hanley et al., 1998). The shares of respondents who purchase insurance under the three payment modes and over the 12 choice occasions are presented in Figure 5. The shares are between 0.60 and 0.75. From both Fig 4 and Fig 5, it is clear that the respondents respond to high insurance premiums by reducing the purchase of insurance (i.e. choose the status quo of not buying the flood insurance) under the three payment modes when the attributes of the insurance are not attractive e.g. high cost of insurance premium. This can be seen to be the case in the fourth and eighth choice occasions. Specifically, whereas the purchase of insurance decreases during the fourth and eighth choice occasions (see Fig. 5), this corresponds to an increase in the proportions of respondents who chose the SQ alternative (see Fig. 4).

### *3.2 Main estimation results*

We estimate the random-parameter error components models for the three insurance payments. To overcome the identification problem, we follow Walker et al. (2007) by first estimating the over-identified model and then setting the lowest variance to zero for identification of the model. For the monetary survey, the status quo alternative yields the lowest variance and was fixed at zero. However, for both non-monetary surveys, the alternative gives the lowest variances was fixed at zero. All models were estimated in preference space. The models were estimated using R (R Core Team, 2015). The results from the maximum likelihood random parameter error components models are presented in Table 3.

**>>>>>>>>>>Insert Table 3 about here<<<<<<<<<<<**

Three results from the random parameter error components model are presented in Table 3. The actual parameter estimates from the three models cannot be compared because of the parameter estimates are confounded by scale parameters, which could be different among the three modes for paying flood insurance premium. Vondolia and Navrud (2017) find that the relative scale parameter for non-monetary payment modes to be lower than monetary payment mode. This underscores that the parameter estimates as presented in Table 3 cannot directly be compared. The first column of the results presented in Table 3 are the results for subsample for which the insurance premium was in labour hours. This model results indicate that the means for flood occurrence, coverage and the insurance premium are statistically significant. If the flood occurrence increases, it means that it takes longer for flood to recur. Therefore, the purchase of flood risk insurance falls. The higher the coverage/compensation, the higher the purchase of flood insurance. When the premium in labour hours increases, the purchase of flood risk insurance falls. The standard deviations for plot size, coverage and flood occurrence are also statistically significant. This measures that there is heterogeneity in preferences for these attributes. The ASC is not statistically significant but and both error components are statistically significant.

The second column presents the results for the sub-sample of respondents who answered the survey in which the insurance premium was required in rice harvest. In this model, the means of flood occurrence, coverage and the insurance premium are statistically significant. It means that when the number of years it takes for flood to recur increases, the purchase of flood risk insurance decreases. Moreover, when coverage increases, the respondents are more likely to purchase flood risk insurance. Similarly, when the insurance premium increases, the demand for flood insurance decreases. In addition to these means, the standard deviations of flood occurrence, plot size and coverage are statistically significant. This means that there is heterogeneity in preferences for flood occurrence, plot size and coverage under the rice insurance premium. The ASC and the third error component are statistically significant.

The last column presents the results for the sub-sample of respondents who were interviewed with survey in which the insurance premium was required in money (GHS). The means of flood occurrence, coverage and premium and plot size are statistically significant. This means that as the number of years it takes flood incidence to recur, the purchase of flood insurance falls. Similarly, as the insurance premium increases, the purchase of flood risk insurance falls. However, if the coverage increases, the purchase of flood insurance increases. Farmers with bigger plot sizes are less likely to purchase flood insurance. In addition, the standard deviations of flood occurrence, plot size and coverage are statistically significant indicating heterogeneous preferences for flood occurrence, plot size and coverage under the monetary payment option. Furthermore, although ASC is statistically significant, the two error components are not statistically significant.

The ASCs are negative statistically significant for the surveys in which insurance premiums were required in money and labour times. This implies that reluctance among the respondents to stick with the SQ of not purchasing the flood risk insurance. The probability of farmer being affected is not statistically significant. This could be attributed to problems in processing probability attribute among the sample especially given the low percentage of the respondents receive above primary education. The statistical insignificance of probability attribute may also be due to the high attribute levels for the probability attribute. Therefore, better risk communication devices need to be considered in future studies. It should be recalled that the plot size attribute was introduced to define the context for the choices being made. The three model specifications perform quite well as indicated by the model characteristics presented in Table 3. For instance, the adjusted rho square are about 0.44 for the three models.

### *3.3 Willingness-to-pay*

The welfare estimates in the form of marginal WTPs are presented in Table 4. The marginal WTPs for flood occurrence are computed using the procedure of Krinsky and Robb (1986). The marginal WTPs were simulated with 10,000 draws using the means and standard deviations. For instance, 10.000 draws were made using the means and standard deviations, and divided by the respective coefficient of the insurance premium attributes. The marginal WTP per household for flood occurrence is 6.504 hours in labour time, 0.425 bags of rice (in 50 kg bags), and 104.142 GHS per annum (US$27). For labour insurance premium, this means that on average, the farmers are willing to contribute about 6.5 hours for a one-year decrease in flooding frequency. For rice insurance premium, this means that on the average, the farmers are willing to contribute about 20 kg of rice yield for a one-year decrease in flooding frequency. Moreover, for monetary insurance premium, this means that farmers are willing to pay on average US$27 for a one-year reduction in flooding frequency.

Similarly, the marginal WTP for flood insurance coverage is 1.792 in labour hours, 0.078 in 50 kg of bags of rice and 12.53 in GHS. This means that to increase the flood insurance coverage (i.e. payout by insurance company) by one 50 kg bag of rice, farmers are willing to pay about 2 hours in labour time, about 5 kg of rice and about 12.53 GHS (US$3). The WTP for insuring an additional plot of irrigation field is 12.425 bags of rice and 533 GHS. These WTP values underscore the relevance of environmental risks among the smallholder farmers. This could be attributed to the fact that environmental and health shocks tend to be most frequent, most costly, and have the most adverse outcomes among low income households (Dercon, 2004b; Alderman and Haque, 2007; Heltberg and Lund, 2009). The box plots for the marginal WTP for the attributes under harvest, labour time and monetary modes for insurance premium payments are presented in Figure 6, 7 and 8; respectively.

The marginal WTP for flood risk reductions reported in this study appear to reflect the high incidence of flood in the Volta Basin in West Africa (see Komi et al., 2016; Hounkpe et al., 2016). The evidence presented in this study also suggests that economic transactions especially pertaining to the decisions on the purchase of flood insurance under monetary as well as *in-kind* payment modes are largely determined by the same considerations. This is because the parameter estimates have the same signs and statistical significance under three modes for paying for the flood insurance premium. Perhaps, experienced and affective considerations in non-monetary transactions may not be strong enough to reverse the analytical thinking required in monetary transactions, as reported in experimental studies (see Lee et al., 2015).

**>>>>>>>>>>Insert Table 4 about here<<<<<<<<<<<**

**>>>>>>>>>>Insert Figure 6 about here<<<<<<<<<<<**

**>>>>>>>>>>Insert Figure 7 about here<<<<<<<<<<<**

**>>>>>>>>>>Insert Figure 8 about here<<<<<<<<<<<**

## 4.0 CONCLUSIONS

With a view to relaxing income constraint on the up-take of insurance for agro-climatic risk transfer, an increasing number of insurance practitioners are looking to *in-kind* insurance premiums to increase the purchase of insurance for agro-climatic risks and human health risks. In this paper, we use a split-sample discrete choice experiment to estimate the preferences of farmers for flood risk reductions in labour time, rice harvest and money insurance premiums. We find that, on the average, farmers are willing to contribute about 6.5 hours in labour time payments, about 20 kg of rice in rice harvest payments and 104.142 GHS (about US$27) for a one-year decrease in flood frequency. Similarly, to increase the insurance coverage (i.e. payout) by one 50 kg bag of rice, farmers are willing to pay about 2 hours in labour time, about 5 kg of rice harvest payments and about 12.53 GHS (US$ 3). These WTP values largely reflect the relevance of flood risk reduction measures among small-scale farmers. However, high preference for flood risk reductions may be a reflection of the increased flood fatalities observed in the Volta River Basin in West Africa over the last two decades. Therefore, efficient flood risk management measures are required in order to reduce the vulnerability of farmers. We also do not find support for claims that the purchase of insurance is higher under *in-kind* insurance premiums. Therefore, the only real benefits of in-kind insurance premiums may be the flexible payment options they provide. Future studies may want to quantify and evaluate welfare implications of adopting monetary and *in-kind* insurance premiums in empirical studies.

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# TABLES

**TABLE 1: ATTRIBUTES AND ATTRIBUTES LEVELS**

| Attribute | Flood occurence | Probability of damage | Coverage (per ha) | Monetary premium (GHS) | Labour premium (Hours) | Rice premium (50 kg bag) |
|---|---|---|---|---|---|---|
| Level 1 | Once in every 6 years | 2 in every 6 farmers | 12 (50 kg) bags | 150 | 15 | 2 |
| Level 2 | Once in every 8 years | 3 in every 6 farmers | 21 (50 kg) bags | 300 | 30 | 4 |
| Level 3 | Once in every 10 years | 4 in every 6 farmers | 30 (50 kg) bags | 450 | 45 | 6 |

## TABLE 2: DESCRIPTIVE STATISTICS OF THE SAMPLE FOR THE THREE SUBSAMPLES

| VARIABLES WITH DESCRIPTIONS | LABOUR TIME | RICE YIELD | MONETARY (GHS) | TOTAL |
|---|---|---|---|---|
| Gender (=1 if female) | 0.31 | 0.36 | 0.34 | 0.34 |
| Age (in years) | 49.4 | 48.01 | 47.86 | 48.43 |
| Education (% respondents with secondary school education and above) | 16.7 | 19.5 | 13.5 | 16.6 |
| Household size | 7.07 | 6.73 | 6.56 | 6.78 |
| Number of years in farming (in years) | 25.13 | 25.0 | 24.04 | 24.74 |
| Output per ha for 2014 main farming season (in metric tonne) | 0.96 | 1.06** | 0.890** | 0.97 |
| Plot size (in ha) | 4.74*** | 3.56 | 3.32** | 3.87 |
| Poor infrastructure (using 1 - 6 scale with 1 = "not important at all" and 6 = "very important") | 5.95 | 5.91 | 5.92 | 5.92 |
| Lack of credit opportunities (using 1 - 6 scale with 1 = "not important at all" and 6 = "very important") | 5.89 | 5.86 | 5.91 | 5.89 |
| Membership in national health insurance (= 1 if yes) | 0.56* | 0.64 | 0.65 | 0.62 |
| High incidence of flood (using 1 - 6 scale with 1 = "not important at all" and 6 = "very important") | 5.06*** | 5.71*** | 5.345 | 5.37 |
| Incidence of other natural disasters (using 1 - 6 scale with 1 = "not important at all" and 6 = "very important") | 4.24 | 3.91* | 4.156 | 4.10 |
| Incidence of flood for past 10 years | 5.33 | 4.85* | 5.810* | 5.32 |
| Last flood damage occurred within last two years (= 1 if yes) | 0.74 | 0.77 | 0.74 | 0.75 |
| Perceptions that flood trend is increasing (%) | 65.91* | 72.73 | 74.81 | 71.14 |
| Perceptions that flood durations are increasing (%) | 64.12** | 74.24 | 74.05 | 70.81 |
| Risk of flood occurring within 5 years (on a 1 - 6 scale with 1 = "very unlikely" and 6 = "very likely") | 4.82* | 5.38*** | 4.857 | 5.022 |
| Chance of flood affecting the farmer (on a 1 - 6 scale with 1 = "very unlikely" and 6 = "very likely") | 4.26* | 4.83** | 4.38 | 4.49 |
| Number of respondents | **132** | **133** | **133** | **398** |

*** Significantly different at 1% level; ** significantly different at 5% level; * significantly different at 10% level.

## TABLE 3: RESULTS OF RANDOM-PARAMETER ERROR COMPONENTS MODELS

| ATTRIBUTES | HARVEST (RICE) | LABOUR TIME | MONEY |
|---|---|---|---|
| SQ (alternative specific constant) | -0.9293 | -5.847*** | -3.5366*** |
| | (0.6151) | (1.0436) | (0.7462) |
| ***Means*** | | | |
| Plot size | -2.6461*** | -0.0512 | -1.5507*** |
| | (1.2271) | (0.1922) | (0.346) |
| Flood occurence | -0.0914*** | -0.1574*** | -0.3056*** |
| | (0.0367) | (0.025) | (0.0498) |
| Probability | 0.0437 | 0.0291 | 0.0468 |
| | (0.0418) | (0.0406) | (0.0411) |
| Coverage | 0.0164* | 0.0434*** | 0.0368*** |
| | (0.0097) | (0.0103) | (0.0099) |
| Premium (monetary in 100, labour in 10) | -0.2142*** | -0.2411*** | -0.2943*** |
| | (0.0538) | (0.0649) | (0.0704) |
| ***Standard Deviations*** | | | |
| Plot size | 8.918** | 0.722*** | 6.4429*** |
| | (4.2996) | (0.2109) | (1.1314) |
| Flood occurence | 0.182*** | 0.0971*** | 0.336*** |
| | (0.0679) | (0.0309) | (0.036) |
| Probability | -0.0311 | 0.0578 | 0.0249 |
| | (0.0325) | (0.0526) | (0.0489) |
| Coverage | 0.0652*** | 0.0596*** | -0.0629*** |
| | (0.0097) | (0.0101) | (0.0084) |
| Sigma 1 (alternative 1) | 0.000 | 0.000 | -0.0368 |
| | FIXED | FIXED | (0.060) |
| Sigma 2 (alternative 2) | 0.4485*** | 0.0334 | -0.0396 |
| | (0.1791) | (0.0773) | (0.0935) |
| Sigma 3 (alternative 3) | 1.4799*** | 15.222*** | 0.000 |
| | (0.2822) | (2.5564) | FIXED |
| ***Model diagnostics*** | | | |
| LL(final) | -1017.221 | -960.7266 | -989.1576 |
| LL(0) | -1748.991 | -1731.413 | -1746.794 |
| McFadden's pseudo-$R^2$ | 0.41 | 0.44 | 0.43 |
| AIC/n | 1.293 | 1.234 | 1.259 |
| BIC/n | 1.333 | 1.275 | 1.300 |
| n(observations) | 1592 | 1576 | 1590 |
| r(respondents) | 133 | 131 | 133 |
| k(parameters) | 12 | 12 | 12 |

*** significant at 1% level.
** significant at 5% level.
* significant at 10% level.
Robust standard errors are in the parentheses.

**TABLE 4: THE MARGINAL WTP VALUES UNDER MONETARY AND IN-KIND PREMIUMS**

| ATTRIBUTES | LABOUR (HOURS) | RICE (BAGS OF 50 KG) | MONETARY (GHS) |
|---|---|---|---|
| PLOT SIZE | 0.051 | -12.425*** | -533.726*** |
| FLOOD OCCURRENCE | -6.504*** | -0.425*** | -104.142*** |
| COVERAGE (BAGS OF 50 KG) | 1.792*** | 0.078*** | 12.528*** |

*** significant at 1% level.

## FIGURES

**# Supposing you have 3 ha in plots**

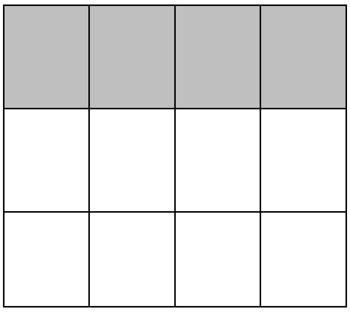
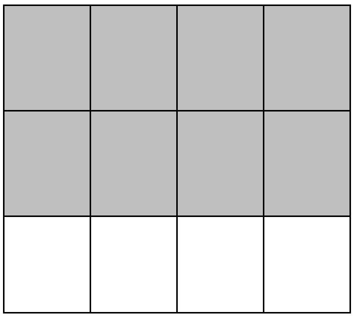
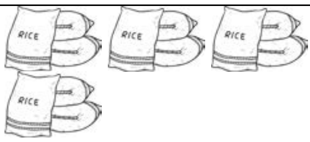
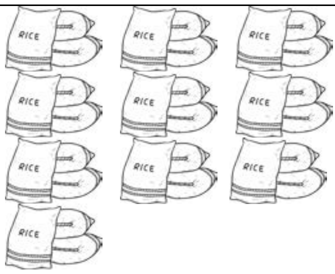
| ATTRIBUTE | SITUATION A | SITUATION B | SITUATION C |
|---|---|---|---|
| Flood occurrence | ONCE EVERY 8 YEARS | ONCE EVERY 8 YEARS | NOT BUY INSURANCE |
| Probability of damage |  2 IN EVERY 6 FARMERS |  4 IN EVERY 6 FARMERS | |
| Coverage per ha |  12 BAGS PER HA |  30 BAGS PER HA | |
| Insurance premium per ha per year | 150 GHS PER HA PER YEAR | 450 GHS PER HA PER YEAR | |
| I prefer: | | | |

**Figure 1: A sample of choice card with monetary insurance premium**

**# Supposing you have 1 ha in plots.**

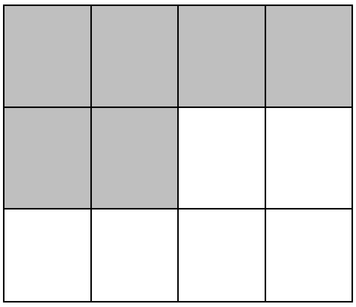
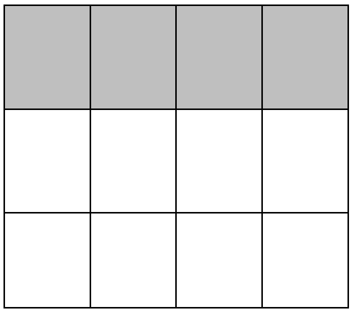
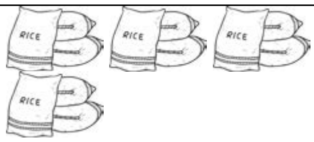
| ATTRIBUTE | SITUATION A | SITUATION B | SITUATION C |
|---|---|---|---|
| Flood occurrence | ONCE EVERY 8 YEARS | ONCE EVERY 8 YEARS | |
| Probability of damage |  3 IN EVERY 6 FARMERS |  2 IN EVERY 6 FARMERS | NOT BUY INSURANCE |
| Coverage per ha |  12 BAGS PER HA |  30 BAGS PER HA | |
| Insurance premium per ha per year | 4 (50 KG) BAGS OF RICE PER HA PER YEAR | 4 (50 KG) BAGS OF RICE PER HA PER YEAR | |
| I prefer: | | | |

**Figure 2: A sample of choice card with rice insurance premium**

# Supposing you have 2 ha in plots.

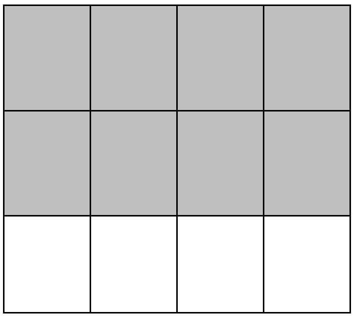
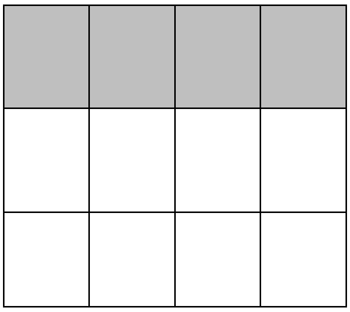
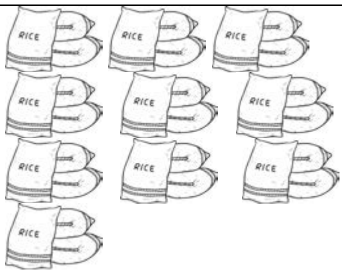
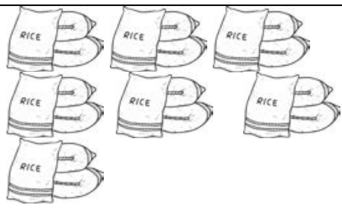
| ATTRIBUTE | SITUATION A | SITUATION B | SITUATION C |
|---|---|---|---|
| Flood occurrence | ONCE EVERY 6 YEARS | ONCE EVERY 8 YEARS | |
| Probability of damage |  4 IN EVERY 6 FARMERS |  2 IN EVERY 6 FARMERS | NOT BUY INSURANCE |
| Coverage per ha |  30 BAGS PER HA |  21 BAGS PER HA | |
| Insurance premium per ha per year | 30 HOURS PER HA PER YEAR | 15 HOURS PER HA PER YEAR | |
| I prefer: | | | |

**Figure 3: A sample of choice card with labour insurance premium**

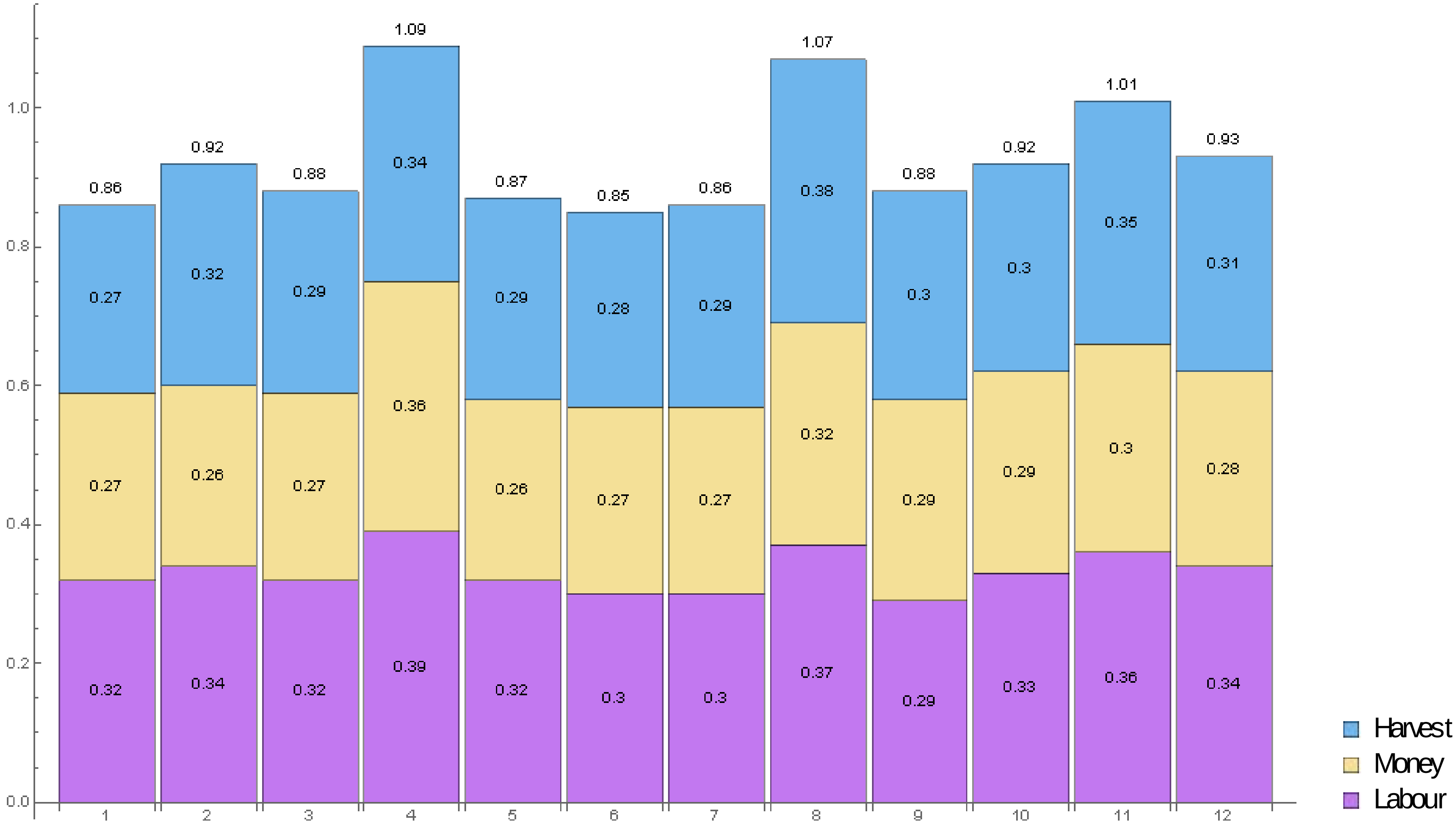



**Figure 4: Stacked bar chart of proportions of respondents who do not purchase flood risk insurance under the three payment modes**

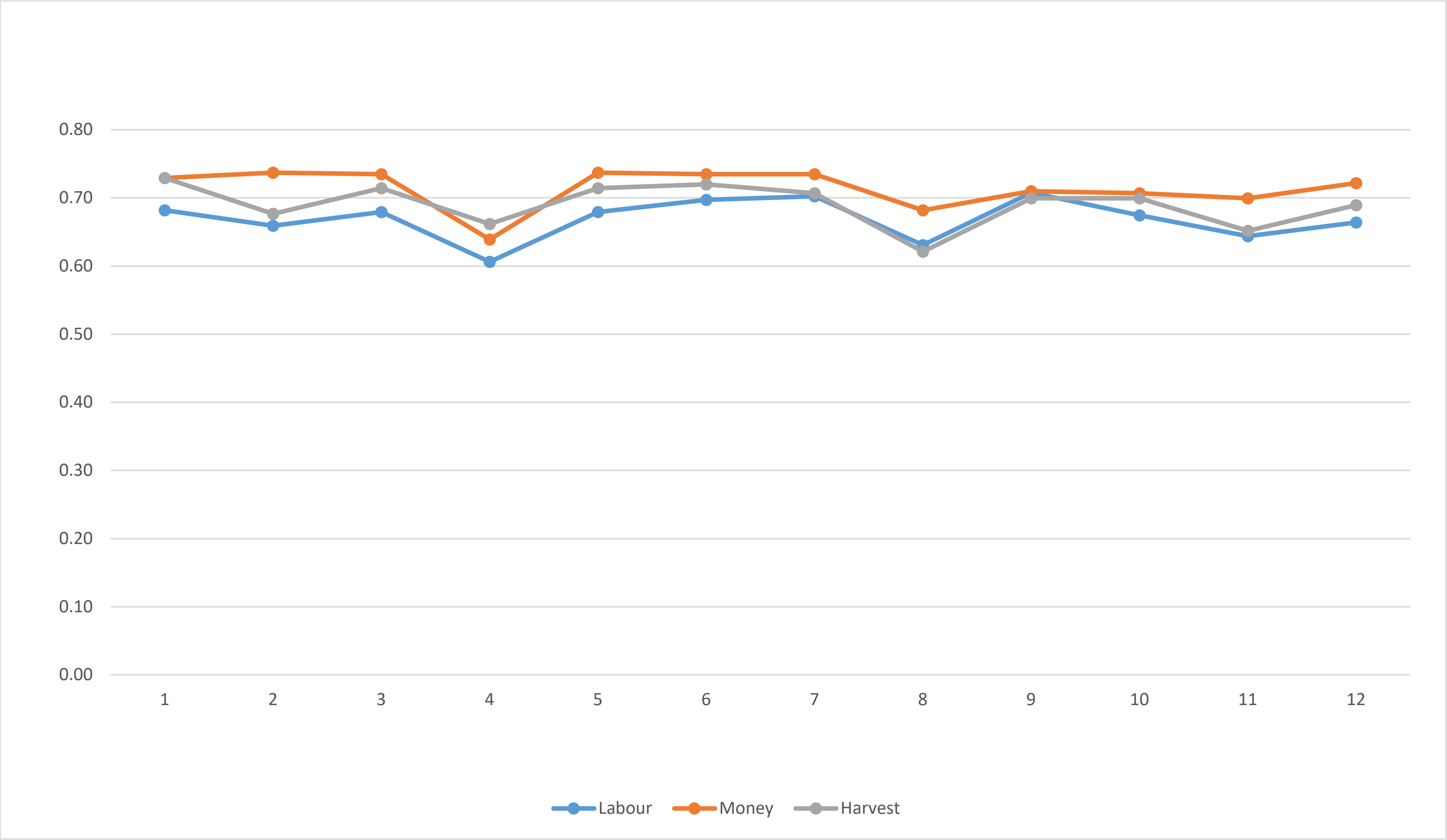



**Figure 5: Proportion of respondents who purchase insurance (i.e. choose alternatives 1 and 2) under the three modes for paying insurance premium**

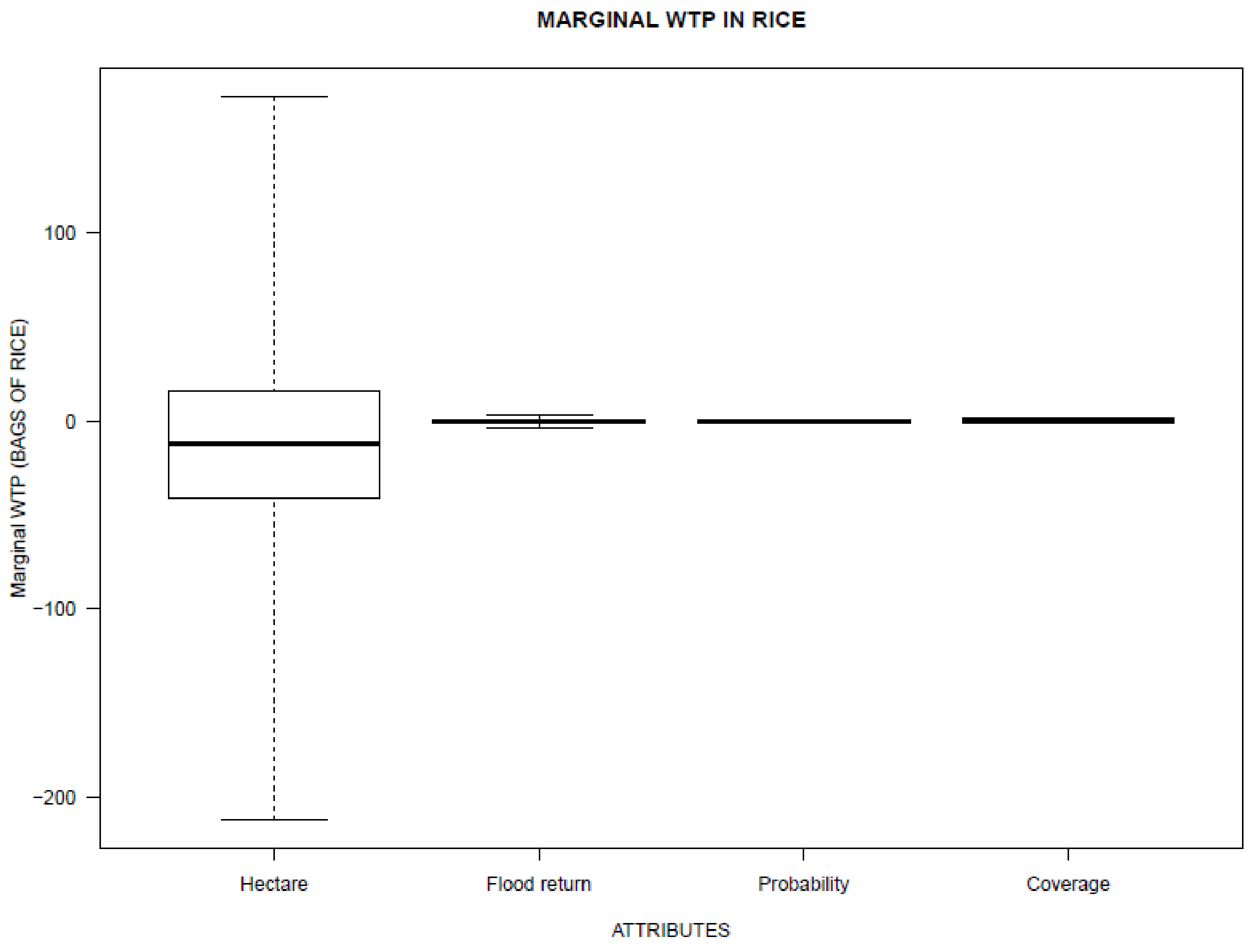



**Figure 6: Box plot of marginal WTP for attributes in rice yield**

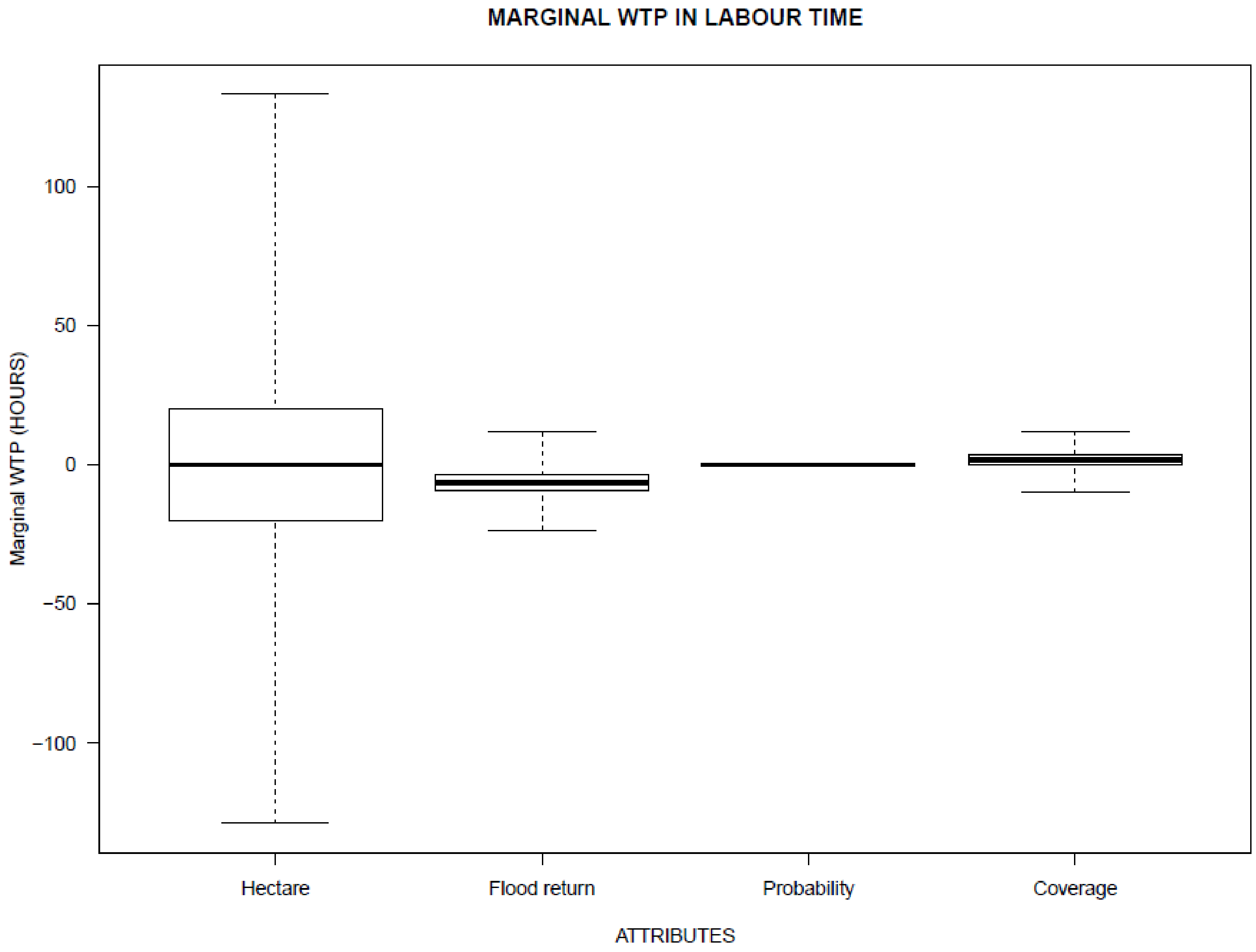



**Figure 7: Box plot of marginal WTP for attributes in labour time**

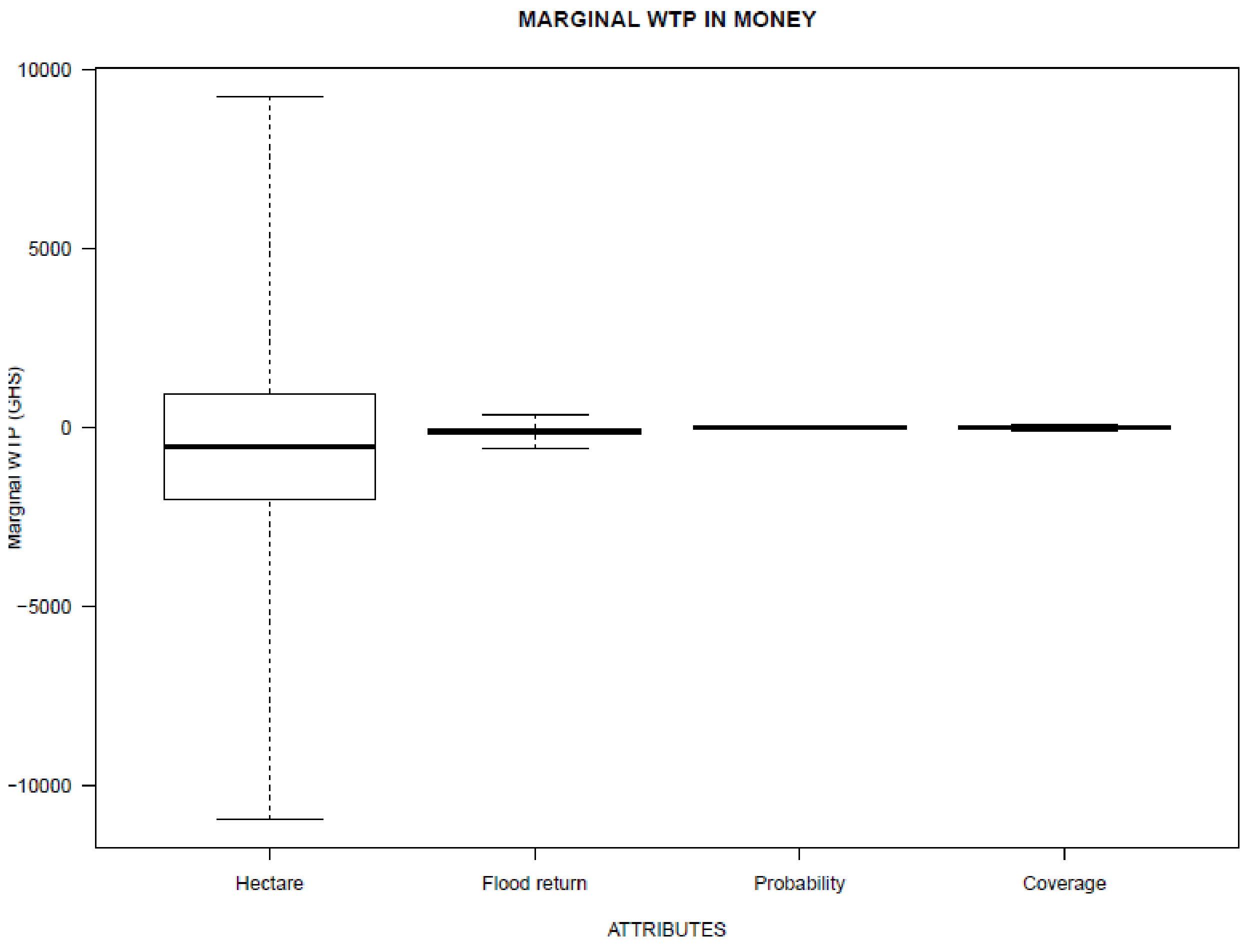



**Figure 8: Box plot of marginal WTP for attributes in money**