

RISK PREFERENCES AND DEMAND FOR INSURANCE UNDER PRICE UNCERTAINTY: AN EXPERIMENTAL APPROACH FOR COCOA FARMERS IN CÔTE D'IVOIRE

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ABSTRACT

This study analyses the willingness-to-pay (WTP) for minimum price insurance in Côte d'Ivoire cocoa farming and the potential role of risk aversion using both experimental gambling approach with real payoffs and contingent valuation (CV) method. The findings reveal a relatively high level of risk aversion among Ivorian cocoa farmers with more than 45 percent of the households exhibiting severe to extreme risk aversion. Considerable interest in minimum price insurance has been found with 66 percent of farmers responding positively to the interest question. Furthermore, it appears that farmers' demand for insurance is affected by a range of independent variables like household size, farming experience, monetary value of livestock, share of cocoa in total income, age of cocoa farm, farm size and social network as coping mechanism. More importantly, we find a highly significant effect of risk aversion on farmers' insurance take-up decisions. In particular, high risk aversion has been found to inhibit the demand for insurance. This suggests that particular attention should be given to farmers' risk aversion in the formulation and implementation of rural development policies. Finally, the WTP analysis reveals that farmers' individual WTP for minimum price insurance are relatively low. Households are on average willing to pay between 8.5 and 13.42 percent of the option value they will receive as a premium depending on the option value.

1. INTRODUCTION

Risk is an unavoidable but manageable element in the business of agricultural production and marketing. Agricultural production can vary widely from year to year due to unforeseen weather, disease/pest infestations, and/or market conditions causing wide swings in yields and commodity prices. These wide swings in yields and output prices generate high variability in farm household income. When the swings significantly reduce income in the short-term, there can be serious repercussions in the absence of effective

risk management tools. Moreover, the existence of such risks has been found to alter households' behaviour in line with their level of risk aversion. In the empirical literature, many researchers have found that risks cause risk averse farmers to be less willing to undertake activities and investments that have higher expected outcomes, but carry with them risks of failure (Adebusuyi, 2004). For example, it is not uncommon to observe farm households in developing countries being reluctant to adopt new technologies even when those technologies provide higher returns to land and labour than traditional technologies. The extent of this reluctance being a reaction to their risk preferences (Yesuf, 2007). As a result, dealing with risks and risk aversion has become increasingly an important aspect of farm management, especially in the developing world where insurance and credit markets are thin or missing.

Though farmers in developing countries can reduce their exposure to risks by using several kinds of informal arrangements and institutions, these traditional strategies only mitigate a small part of overall risk (Alderman, 2008; Dercon, 2002), especially when those swings are systemic shocks to the whole sector, like instable commodity price. Price volatility leaves a farmer uncertain about whether he will receive a high price or a low price for his crops at the end of the season. The problem is, however, not limited to how much cash a farmer receives for his harvest. Every investment decision a farmer makes during the crop cycle is a difficult one, since he doesn't know whether he will be able to pay back the loan for the investment (labour, fertilizer, equipment & repairs, etc.). Uncertain prices also create risks for banks that might lend to farmers. Often, they will raise interest rates to cover uncertain risks, or simply refuse to provide credit at all. Consequently, it is not surprising that a lack of price risk management tools is one of the foremost reasons why poor farmers stay poor in developing countries.

In an attempt to help farmers in dealing with their exposure to commodity price risks, this paper focuses on the interaction between farmers' risk preferences and the potential demand for cocoa price insurance in rural Côte d'Ivoire. Using data collected at the field level, it seeks to assess farmers' attitude towards risk by mean of an experimental gambling approach and examine the determinants of risk aversion. Then, the issue of demand, namely farmers' willingness to pay (WTP) for commodity insurance, empirically for the case of minimum price insurance is explored. We are particularly interested in examining the effect of risk preferences on the decision to purchase potential price insurance. The results show a relatively high level of risk aversion among Ivorian cocoa farmers. More importantly, we find a strong relationship between the level of risk aversion and farmers' insurance take-up

decisions. In particular, high risk aversion has been found to inhibit the demand for insurance.

A good understanding of the factors that enhance or impede demand for price insurance will enable the relevant authorities and policy-makers to reduce farmers' exposure to risk by providing them with the most appropriate price insurance contract. They would also like to know the socioeconomic characteristics of households that influence farmers' attitudes vis-à-vis to risk. Such is, no doubt, of vital importance for the cocoa market investment planning but also for the outcome of rural development programs. Considering the share of the population involved in the cocoa sector in Côte d'Ivoire¹, a development policy or strategy that allow farmers get more stable income may have some strong pro-poor effects. Finally, it is important to notice that while the question of whether risk aversion needs to be taken into account is often quite easy to judge, the novelty of this approach is that it gives some approximate quantitative indication of whether risk aversion really matters.

The paper is structured as follows: After reviewing the literature on estimating risk preferences and on insurance demand in section 2, we provide a brief description of the study area and sampling in the third section. Section 4 deals with the methodology on eliciting risk preferences, including the experimental design and econometric specifications. In section 5, we provide an analysis of household perceptions of risks and discuss the WTP survey as well as the methodological issues in evaluating the demand for insurance. Section 6 presents and discusses the empirical results while Section 7 concludes by summarizing the findings and offering policy recommendations.

2. REVIEW OF LITERATURE ON ANALYTICAL METHODS

2.1. MEASURING RISK PREFERENCES

Considerable research has attempted to provide empirical evidence of individuals' risk attitudes. These attempts can be classified into two basic categories: the econometric approach and the experimental approach.

The econometric approach is based on individuals' actual behaviour. The pioneering work by Moscardi and de Janvry (1977) used a safety-first rule approach to find that the measurement of behaviour toward risk is explained by a set of socioeconomic

and structural variables that characterize peasant households. He found for example that age, years of schooling of the household head and family size affect the risk attitude of the household. He found that older farmers tend to be less prone to take risks than younger ones. Later, individual risk attitudes have been elicited assuming expected utility maximization. One of the best-known methods is that of Antle (1987), who used a moment-based model to estimate risk attitudes with Indian data. The results show that the population is characterized by Arrow-Pratt and downside risk aversion and there is a considerable heterogeneity of risk attitudes in the population. Pope and Just (1991) proposed and implemented an econometric test for distinguishing the class of preferences for potato supply response in Idaho. The data reject constant absolute and partial relative risk aversion and are congruent with constant relative risk aversion.

The experimental approach is based on hypothetical questionnaires regarding risky alternatives or risky games with or without real payments. Early empirical work in this line was conducted in rural India. Binswanger (1980) used an experimental gambling approach with real payoffs to estimate the structure of risk preferences of 240 Indian farmers. He found that, at high payoff levels, virtually all individuals are moderately risk-averse with little variation according to personal characteristics. Wealth tends to reduce risk aversion slightly, but its effect is not statistically significant. Later in 1998, Wik and Holden used the same method to find a wide spread in risk aversion for 143 farmers in Northern Zambia. The experimental measures indicate that on average, more than 80 percent of the farmers are moderately to extremely risk averse; that they exhibit decreasing absolute risk aversion and increasing partial risk aversion; and, that they are more risk averse in games with gains and losses than in games with gains only. Holt and Laury (2002) found that income has a mildly negative effect on risk aversion. They use their observations to argue that increased incentives appear to change risk attitudes, leading to greater risk aversion. With real laboratory payoffs of several dollars, most subjects are risk averse and few are risk loving. In particular, increase in risk aversion is observed when payoffs are scaled up. More recently in 2007, Mahmud Yesuf used a random sample of 262 farm households from seven villages to participate in an experiment in Ethiopia. He observed that a majority of the farm households exhibit intermediate, severe, and extreme risk aversion. Even at the lowest level of the game, about 29 percent of the farm households chose the alternatives representing severe to extreme risk aversion. This proportion increases to about 56 percent at the highest level of the game. The results indicate increasing partial risk aversion in which individual farm households are more risk averse as the size of the game increases.

¹ More than one third of the population, i.e. 6 millions individuals (ITF, 2002)

Both approaches have their advantages and disadvantages. While the econometric approach is based on individuals' actual behaviour, it can be criticized for confounding risks behaviour with other factors such as resource constraints faced by economic actors (Eswaran and Kotwal 1990). Thus, it may appear as if individuals are more risk averse than they truly are (Binswanger 1982). This is particularly important in developing countries where market imperfections are prominent and consumption and production decisions are non-separable (Wik and Holden 1998). For experimental studies, the advantage is that one can design experiments where many of the features are under the control of the experimenter, and where it is therefore easier to focus on testing the assumptions of economic theories. However, the most pervasive problem of the experimental approach is hypothetical bias when the experiments are launched in purely hypothetical settings. Nonetheless, the experimental method has increasingly been recognized as a more desired method for eliciting and measuring risk aversion.

To our knowledge, no earlier published studies on risk attitudes of peasants in Côte d'Ivoire exist. Côte d'Ivoire peasants are faced with market imperfections such as rationed credit markets, missing land markets, missing insurance markets, and limited access to commodity markets. Therefore, for the purpose of this study in Côte d'Ivoire, we found the experimental approach to be most appropriate for eliciting estimates of cocoa farmers' risk aversion. As we use an experimental approach, we attempt to avoid the problem of hypothetical bias by using real payoffs.

2.2. DEMAND FOR AGRICULTURAL INSURANCE

Reviews of empirical literature on agricultural insurance demand show that there are three ways that have been utilized to determine the willingness to pay (WTP) of farmers for insurance. The first involves directly ask the producers, what they would be willing to pay for an insurance scheme described in detail to them and is related to the literature on contingent valuation method (the contingent valuation approach). The second involves inference of the willingness to pay from analysis of the patterns of production and other behaviour of producers. This is based on a revealed preference technique (the revealed preference approach). The third method involves the use of theory along with the combination of microeconomic household information, and market information to estimate indirectly the appropriate premiums. The idea here is to calculate farmers' willingness to pay by comparing their utility in a world with and without insurance and determining what they

would be willing to pay to be indifferent between moving from one world to another (the indirect approach).

There are very few studies relevant to agricultural insurance that use the contingent valuation (CV) approach. Patrick (1988) analysed producers' demand for a multiple peril crop insurance program with indemnities based on actual yields, and a rainfall insurance program with indemnities based on area rainfall, and used Tobit procedures to analyze factors influencing farmers' WTP for the alternative programs. Vandeveer and Loehman (1994) applied both dichotomous choice and ranking of activities in a study of farmer response to modifications in crop insurance. The ranked responses were used in a ranked Logit model to derive WTP. Recently in 2006, Sarris, Karfakis and Christiaensen used this method to find farmers' WTP for price insurance in Tanzania and found a substantial demand for price insurance. The WTP analysis revealed that it is mainly instability related variables that contribute positively to the demand for insurance, while the existence of coping mechanisms contributes negatively. It also revealed that the values of individual WTP for coffee and cashew nut price insurance are significant shares of the underlying minimum prices insured. We applied the CV method in this study.

The revealed preference method has been utilized in an early paper by Binswanger and Sillers (1983) to estimate the risk attitude parameters of farmers, but did not consider explicitly insurance. The first paper using a methodology of this type to estimate risk premiums for insurance is the one by Gautam, Hazell and Alderman (1994). In that paper the farm household's behaviour is assumed to be described by the maximization of the expected value of an inter-temporal utility function. The production, saving, labour allocation, diversification, borrowing, and insurance decisions are assumed to be endogenous. The equilibrium conditions of the optimization problem are manipulated to infer the production and diversification decisions of the household as functions of both standard variables as well as a variable that measures the relative preference of the household for risky versus non-risky income. The authors, using panel data, estimate the WTP of farmers for drought insurance and find that it is above the cost of actuarially fair drought insurance, and hence that the provision of such insurance would be commercially viable. The same approach is essentially followed by Sakurai and Reardon (1997) who utilized panel data for Burkina Faso. The additional feature of this study is that the researchers regressed their estimates of farm level demands for drought insurance on a set of variables, so as to identify variables that increase or decrease such demand. They found, as expected, that the demand for drought insurance depends on the perceived probabilities of droughts, and is higher for

regions with higher probabilities. They also found that variables such as the size of cultivated area, and the age of household significantly affect positively the demand for insurance, while the amount of off-farm income, the availability of public aid and private gifts, and the size of household significantly affect negatively the demand for insurance.

There are also some studies attempting to estimate WTP for agricultural insurance by the indirect approach. Bardsley, Abey and Davenport (1984), use a simulation model to estimate the amount of insurance at a given minimum price that will be purchased, per unit of insured quantity. Hazell, Bassoco and Arcia (1986) applied a programming model to infer the demand for crop yield insurance by the representative farmer in Mexico. Fraser (1992) uses an indirect method to estimate WTP for crop insurance. He does this by estimating and comparing certainty equivalents, in the presence and absence of insurance, of expected utility, based on the mean-variance framework and constant relative risk aversion. With the same method, Hill (2006) used data from Uganda to assess farmers' risk preferences and risk perception as well as the demand for price insurance. Access to price information was found to influence the degree of risk perceived. Also substantial demand for price insurance was found and the estimates show wide variation in the WTP for insurance.

3. STUDY AREA AND SAMPLING

The principal area covered by this study is the department of Soubé, located in Western Côte d'Ivoire, at the heart of cocoa belt (Bas-Sassandra Region, see Figure A.1 in Appendix). The department is the first cocoa producing area in Côte d'Ivoire with 28 percent of the national production and contains the highest number of cocoa producers per department in the country. Apart from being cocoa-producing area, major export commodities such as coffee, oil palm and hevea are also produced in Soubé as well as many subsistence crops (yam, rice, plantain, tomatoes, groundnut, etc). The study was carried out in the whole department subdivided in seven (7) Sub-Prefectures²: Buyo, Grand-Zattry, Meagui, Soubre, Okrouyo, Liliyo, Oupoyo.

Primary data were exclusively collected from 362 cocoa producers. An individual was considered as cocoa producer if and only if he possessed a least one cocoa field among others. Therefore, non-cocoa

producing farmers were not included in the sample. The survey used a two-stage stratified sampling design with geographical proximity as the stratification variable, the villages as the primary sampling unit and the households as the secondary sampling unit. A total of fifteen (15) villages from the seven (7) Sub-Prefectures of the department were allocated to three strata or zones (by geographical proximity, see Figure A.2 in Appendix). The selection of the villages is based on unequal probability sampling method. This method ensured that big villages (in terms of total number of cocoa producers) will be selected. The number of producers³ per strata was then determined proportionally to the size of the strata. In a sample village, a household was a qualified respondent if he resided in the village for over 6 months and is engaged in cocoa production activities (not necessarily within the village).

4. ELICITING FARMERS' RISK AVERSION BEHAVIOUR

4.1. DESIGN OF THE EXPERIMENT

In our experiment, subjects were confronted with a series of choices among sets of alternative prospects (gambles) involving real money payment. The subject's choice among these alternative prospects is taken as an indication of the degree of his/her risk aversion

We follow an experimental design developed by Binswanger (1980) and recently used by Yesuf (2007) to reveal risk preferences of farm households in Western Côte d'Ivoire. A series of schedules of prospects (called games) similar to those shown in Table 1 were presented to each subject. Each game lists six prospects, each with 50% probability of winning. Each subject was asked to select one of the six prospects: O, A, B, C, D, or E. Once chosen, a coin was tossed and the subject received the left hand amount if the coin showed heads and the right hand amount if the coin showed tails. Every game contains a safe alternative, which is alternative O.

² The Sub-Prefecture is an administrative subdivision (or a circonscription administrative déconcentrée) which carries out limited functions, overseen by an appointed Sub-Prefet who reports to a Prefet appointed by the National Government at the Departmental level.

³ We randomly select households within each village. We stratify the sample according to village, household size and average cocoa production in the last three years.

Table 1: The basic structure of the experiment

Choices	Bad Outcome "Heads"	Good Outcome "Tails"	Expected Gain	Standard deviation or Spread	Risk Classification*
O	100	100	100	0	Extreme
A	90	180	135	45	Severe
B	80	240	160	80	Intermediate
C	60	300	180	120	Moderate
D	20	380	200	180	Slight to neutral
E	0	400	200	200	Neutral to preferring

Source: Adapted from Binswanger (1980)

* According to Binswanger (1980) classification.

The selection of alternative O is equivalent to not playing the game. If the subject selected alternative O, she/he received 100 FCFA whether she/he got a head or a tail. If she/he chose alternative A instead of O, her/his expected gain increased by 35 FCFA, but a bad luck alternative (heads) would now give her/him 10 FCFA less in return than she/he would have received with the safe alternative O. In other words, in choosing A instead of O, the standard deviation in gain is increased from 0 to 45 FCFA. For the successive alternatives, A to B, B to C, and C to D, the same is true: the expected gain increases, but so does the spread between the two outcomes. Alternative D and E have the same expected gain, but alternative E has larger spread.

When risk is viewed in terms of uncertainty in gains, income or wealth, as in utility based choice theories, the alternatives involve more risk the further down you get in Table 1. This means that a decision-maker possessing a utility function concave in wealth, income or gain would demand a higher risk premium to accept prospect B rather than its expected outcome than she/he would demand to accept prospect A rather than its expected outcome. Whether she/he prefers prospect B over prospect A depends on the degree of concavity of his utility function. The different prospects are classified from extreme risk aversion (alternative O) to neutral to preferring (alternative E). The classification is the same as the one used by Binswanger (1980).

In order to observe a farm household's behaviour following different outcomes, and hence the nature of partial risk aversion, the experiments were made to be conducted at different levels (see the full format of the games in Table A.1 in Appendix). Though the amounts may seem low, it must be recalled that incomes in the study area are very low, so the amounts listed indeed provide significant incentive for respondents to carefully consider the options and reveal their true preferences. On average, each household won a sum of 900 FCFA, which is about three times the rural area daily wage in the country. Each individual played games 1 to 3. The last two games (1000 FCFA and 5000 FCFA) were derived from the 100 FCFA game by multiplying all amounts by 10 and 50.

The three games were played, at 100, 1000 and 5000 FCFA level. The first two games were real, i.e., the individual actually received the payment. But because of budget-restrictions, we included a hypothetical game. Thus, the third game was set hypothetical. The individuals were told before playing the games that one of the games would be hypothetical, but they were not told which game. They were paid after playing the three games, told that game 3 was the hypothetical one. In this way we hoped the individuals would play all games as if they were real.

The newness of the experiment to the farmers necessitated extra care in explaining the process. It was vital to the experiment that participants clearly

understood that they will receive the amount of money they had won at the end of the game sequences. The six alternatives were carefully explained. Because the majority of the farmers were illiterate, posters with the money stuck on them for each alternative were presented. Farmers were gambling separately to avoid that the “luck-factor” of a successful player would bias results of successive players. Two hypothetical rounds at the 100 FCFA scale were played to familiarize the subjects with the games and to determine and correct any potential problems before starting the experiment. In general, farmers had no problems in understanding the game.

4.2. ECONOMETRIC ANALYSIS OF RISK AVERSION BEHAVIOUR: THE ORDERED LOGIT MODEL

Before turning to the analysis of the effect of risk aversion on the decision to purchase potential price insurance, we examine how personal and farm characteristics are correlated with risk aversion. This is an issue which has not been subject to much empirical analysis in the literature. To analyse the determinants of risk aversion we first need to decide how to treat the dependent variable. Binswanger (1980) based on the lottery selections made by the respondents, computed point estimates of partial risk aversion coefficients S and regressed these (in logarithms, $\ln S$) on various personal characteristics such as gender, occupation, age, income, financial and nonfinancial assets, and schooling. However, at the simplest level, one can choose to define the dependent variable on another way; that is, to give numbers one (1) to six (6) to choice O to E, and use these numbers as regressors. Binswanger (1982) reported little impact of using either $\ln S$ or the choices 1 to 6 as dependent variable on regression results.

Furthermore, our experimental data fits into an ordinal econometric model; i.e. an ordered Logit (Probit) model (Maddala, 1983; Wooldridge, 2002). An ordered Logit (Probit) model exploit the fact that the dependent variable outcomes, categories of risk aversion, have a natural (ordinal) ranking ranging from 1 (extreme risk aversion) to 6 (risk loving behaviour). This model has an advantage in that we need not assume a particular functional form of the utility function to analyse the risk aversion behaviour of farm households. Therefore, we simply use the underlying latent variable model to analyse the observe choices.

The ordered Logit (Probit) model for the observed variable $\mathcal{Y}$ (conditional on explanatory variables $\mathcal{X}$) can be derived from a latent variable model. Assume there is a latent variable $\mathcal{Y}_i^*$ measuring the degree of

risk aversion of the i^{th} decision maker that can be described as:

$$\mathcal{Y}_i^* = \mathcal{X}_i \beta + u_i \quad (1)$$

for a $k \times 1$ parameter vector β , stochastic disturbance term u_i and a vector of regressors $\mathcal{X}$ which are common factors known to influence attitude towards risky behaviour. The description of these factors as well as their expected sign is presented in Table A.2 in Appendix.

The six outcomes for the observed variable $\mathcal{Y}_i$ are assumed to be related to the latent variable through the following observability criterion:

$$\mathcal{Y}_i = m \text{ if } \alpha_{m-1} \leq \mathcal{Y}_i^* < \alpha_m \text{ for } m = 1, \dots, 6 \quad (2)$$

for a set of unknown cut points (or threshold parameters) α_0 to α_6 to be estimated jointly with the parameter vector β , where:

$$\alpha_0 < \alpha_1 < \alpha_2 < \alpha_3 < \alpha_4 < \alpha_5 < \alpha_6,$$

$$\alpha_0 = -\infty \text{ and } \alpha_6 = \infty.$$

$$y_i = \begin{cases} 1 \Rightarrow \text{extreme} \\ 2 \Rightarrow \text{severe} \\ 3 \Rightarrow \text{intermediate} \\ 4 \Rightarrow \text{moderate} \\ 5 \Rightarrow \text{slight-to-neutral} \\ 6 \Rightarrow \text{neutral-to-prefering} \end{cases}$$

$$\text{if } \alpha_0 = -\infty \leq y_i^* < \alpha_1$$

$$\text{if } \alpha_1 \leq y_i^* < \alpha_2$$

$$\text{if } \alpha_2 \leq y_i^* < \alpha_3$$

$$\text{if } \alpha_3 \leq y_i^* < \alpha_4$$

$$\text{if } \alpha_4 \leq y_i^* < \alpha_5$$

$$\text{if } \alpha_5 \leq y_i^* < \alpha_6 = \infty$$

We assume the disturbance term has a logistic distribution yielding the ordered Logit model⁴.

The maximum likelihood (ML) estimation is used to estimate the parameters of the ordered Logit model.

5. INTEREST IN AND POTENTIAL DEMAND FOR MINIMUM PRICE INSURANCE

5.1. PERCEPTION OF RISK SOURCES WITHIN FARMERS

The first step toward understanding households' vulnerability, as a prelude to understanding their demand for insurance, entails characterization of the risk environment they face. It is important to know which types of shocks are commonly encountered. This section presents the most common risks faced by farmers in our sample along with their perceptions about each source of risks.

4 A standard normal distribution could also be assumed, which would lead to an ordered Probit model. Our results using both approaches are similar and so only the ordered Logit results are presented.

Based on prospecting results coming from the field, a total of 8 sources of risk were presented to respondents in the survey. Farmers were asked to identify the sources of risk they have experienced over the past five years and to score each source of risk (on a 5-point Likert scale⁵) from 1 (no impact) to 5 (high impact) to express how significant they considered each source to be of risk in terms of its potential impact on the performance of their farm and their annual income. In doing this, farmers selected and ranked the different sources of risk from the less important to the most important (i.e. the source of risk they feared the most). The identified risk sources and their order of importance are presented in Table 2 below.

Analysis of ranking of risk sources by cocoa farmers using mean of importance rating or score indicated output (cocoa) price fluctuation as the first risk source with highest mean score of 4.01. Indeed, within the overall trend of volatility in cocoa world market prices, producer prices in Côte d'Ivoire had been very stable in the past under the government price stabilisation system. With the liberalisation of the cocoa sector, empirical results regarding absolute price levels have been mixed; but as one would expect, producer price volatility has increased (ul Haque, 2004) as a result of the abolition of the price guarantee function. The operators and especially small-scale farmers found themselves faced with price risks, which they were not prepared to confront.

5 A Likert scale is psychometric scale commonly used in questionnaires, and is the most widely used scale in survey research. When responding to a Likert questionnaire item, respondents specify their level of agreement to a statement. The scale is named after its inventor, Rensis Likert.

Table 2: Mean scores and rank of sources of risks (n = 362)

Risk Sources	Importance Score	Rank by Mean Score
Production		
Drought	2.14	5
Pest/disease	3.66	2
Floods	1.30	6
Market		
Input access	2.85	3
Output price	4.01	1
Personal		
Ill-health/death	2.64	4
Unavailability of		
Labour	1.03	8
Land (unsecured)	1.16	7

Source: Own computation from survey data

Next in importance are pest/diseases with a score of 3.66. The importance of this risk source can be explain by the fact that cocoa farmers in Côte d'Ivoire has experienced these last year some important failure in yield due to diseases like black pod and swollen shoot. The third risk source is related to input access with a mean score of 2.85 followed by ill-health/death of a member of the household. This section, to conclude, shows that cocoa farmers in Côte d'Ivoire ranked market risks, to be precise output price risk (the risk that actual cocoa price will be different than originally

expected price), as the most important source of risk they face.

To deal with risks, farm households use several kinds of informal arrangements. The most common coping mechanisms used by the majority of farmers in our sample are diversification of their crops, sharing risk within social networks and/or relying on wealth that results from the past flow of precautionary savings. These mechanisms, although they help farmers in mitigating their exposure to risks, are incomplete. The literature reveals that traditional risk management

measures are costly. They lead to a considerable reduction of farmers' incomes, particularly poorer farmers (Rutten and Youssef, 2007). There is therefore a necessity to make modern risk management instruments like (price) insurance available for farmers.

5.2. WTP FOR PRICE INSURANCE SURVEY DESIGN

Basically, price insurances guarantee a minimum price for a specific quantity over a predetermined period of time (Sarris, 2002), for which the policy holder has to pay a premium upfront. The data set on farmers' WTP for price insurance came from a household survey executed after the experimental sessions on risk attitude.

Using the contingent valuation method, the survey asked a variety of questions related to cocoa price insurance. To begin with, detail description of how a minimum price insurance contract works was presented to farmers. After this description farmers were asked on whether such a contract would interest them. Then the questionnaire proceeded to ask whether farmers would be willing to pay various amounts for given minimum price contracts. WTP questions were administered only to those respondents who declared that they were interested in price insurance.

In line with farmers' price experience over the past five years, the contracts were designed to span the experience of the previous five years. Three hypothetical contracts were designed, offering a

progressively higher price, for a correspondingly higher premium. In particular, cocoa farmers were asked about their willingness to pay for a contract

paying a minimum of 400 FCFA per kg, or one paying a minimum of 600 FCFA per kg or one paying 800 FCFA per kg for cocoa marketed in 6 months time from the period of the survey. The 6 month advance period over which the hypothetical contracts were structured relate to the time of the survey relative to the time of the new crop harvested in the next marketing year.

Each farmer was asked whether he/she would be willing to pay a certain amount for each of these contracts, and the answer was YES or NO. For each contract three different bid values (namely prices to pay) were selected. For instance, for the cocoa contract that stipulated a minimum price of 400 FCFA the bid values were 30, 50, and 75. For the contract that stipulated a minimum price of 600 FCFA the bid values were 50, 100 and 150 and for the contract that stipulated a minimum price of 800 FCFA the bid values were 100, 200 and 250. Each farmer was randomly assigned to answer whether he/she would be willing to pay one of these bid values for each contract. In other words each farmer was asked about only one bid value for each contract.

In particular, in each village, the sample was randomly assigned in three groups and each group was presented with only one bid for each contract (see Table 3). This is to ensure that bargain effects will not influence farmers' answers to WTP questions.

Table 3: Bid values for price insurance contracts

	Cocoa Price Insurance Contracts (all amount in FCFA)		
	Minimum Price	Minimum Price	Minimum Price
Village group	400 FCFA	600 FCFA	800 FCFA
Group 1	30	50	100
Group 2	50	100	200
Group 3	75	150	250

Source: Authors

The first group was asked whether they are willing to pay 30 FCFA for the contract with minimum price 400 FCFA, 50 FCFA for the contract with minimum price 600 FCFA, and 100 FCFA for a contract with minimum price 800 FCFA. The second group was asked whether they were willing to pay 50, 100, and 200 FCFA for each of the above three contracts respectively and the third was asked whether they were willing to pay 75, 150 and 250 FCFA for each of the above three contracts.

5.3. MODELLING WTP FOR PRICE INSURANCE: THE HECKMAN 2-STAGE PROCEDURE

Household's insurance demand in our experiment is thus modelled using discrete choice framework. It was expected that not all the households would be interested in minimum price insurance. In such a situation, an important econometric problem that arises in the estimation is sample selectivity bias. This is relevant for the WTP variable, but it is not observed for the sample as a whole. By excluding individuals who are not interested in minimum price insurance, the dependent variable is censored and the residuals do

not satisfy the condition that the sum of the residuals must equal zero (Maddala, 1977).

This problem is handled in this study by using the Heckman method, which consists of two steps (Heckman 1974; 1980). First, the probability of being interested in insurance is estimated by means of a Probit maximum likelihood function on both farmers who are interested in insurance and those who are not. The decision to take up price insurance by the *ith* household is modelled by the following selection model:

$$z_i^* = \alpha X_i + u_i \quad (3)$$

where z^* is an unobserved latent variable determining a household's desirability of insurance, X is a vector of farm households' current asset endowments, household characteristics and location variable hypothesized to affect the take up decision, and u is the random disturbance term distributed with mean 0 and variance 1. The observed binary variable will be:

$$\begin{aligned} z &= 1 \text{ if } z^* > 0, \text{ (for insurance takers)} \\ z &= 0 \text{ if } z^* \leq 0, \text{ (for insurance non-takers)} \end{aligned} \quad (4)$$

From the Probit equation the inverse of the Mill's ratio (IMR), λ , which is the ratio of the ordinate of a standard normal to the tail area of the distribution, can be computed (Heckman 1980). The Mill's ratio reflects the probability that an observation belongs to the selected sample and is obtained as follows:

$$\hat{\lambda}_i = \frac{\phi(X_i\hat{\alpha})}{\Phi(X_i\hat{\alpha})} \quad (5)$$

where ϕ is the density function of a standard normal variable, Φ is the cumulative distribution function of a standard normal distribution and λ is the Mills ratio term.

In the second step, the WTP for insurance contract is modelled by mean of a Probit model where the IMR is included as an additional explanatory variable. This technique eliminates the potential sample selection bias. If λ is not statistically significant, then sample selection bias is not a problem (Heckman 1979; 1980). Three independent Probit models⁶ corresponding to each of the three minimum price contracts have therefore been estimated. In addition to the bid levels, all variables that affect the insurance take-up decision of respondents are included in the WTP Probit regressions. Table A.3 in Appendix gives an overview of the explanatory variables used in the analysis of farmers' interest in and WTP for minimum price insurance.

6. EMPIRICAL RESULTS

⁶ A Trivariate Probit model has also been estimated to take into account the potential correlations among WTP decisions. The results show that the pairwise correlation coefficients between the error terms of the three equations are not statistically significant. Therefore, it is not misleading to estimate three independent Probit models. Results of the Trivariate Probit estimation are not presented here.

6.1. RISK AVERSION AND ITS DETERMINANTS

Knowledge on farmers' attitudes towards risks is important in determining the strategies for agricultural development. In an attempt to explain farmers' risk attitudes, an ordered Logit model has been estimated for each game level. This is to capture variations in farmers' risk behaviour at different investment scales or size (as measured by the different game levels).

6.1.1. RESULTS OF THE EXPERIMENT

We start by exploring the responses of participants to each set of the experiment. Table 4 below presents the distribution of risk aversion behaviours for each level of the experiment. Observe that at low level of the game, the distribution was rather evenly spread over all classes of risk aversion. But as the game level rose, the distribution shifted to the left and became more peaked, i.e., risk aversion increased. Even at the lowest level of the game, which is the 100 FCFA game, more than 15 percent chose the alternatives representing severe to extreme degree of risk aversion. When the game level increased to 1000 FCFA, more than 30 percent chose the two most risk averse alternatives and at the 5000 FCFA game level, we found more than 45 percent falling in these risk aversion classes. Considering the slight-to-neutral and neutral-to-preferring alternatives, the percentage choosing these alternatives was reduced from 30 percent at the 100 FCFA game level to only 13 percent and 8 percent in the 1000 FCFA level and 5000 FCFA level respectively.

Table 4: Distribution of farmers' choices in risk game by pay-off level (% of farmers)*

Games	Extreme (%)	Severe (%)	Intermediate (%)	Moderate (%)	Slight to Neutral (%)	Neutral to Preferring (%)
100 FCFA. (game 1, real)	8.84	9.12	28.73	22.93	17.68	12.71
1000 FCFA. (game 2, real)	14.92	17.96	33.15	20.72	6.91	6.35
5000 FCFA. (game 3, hyp.)	16.85	29.28	30.94	14.92	4.42	3.59

Source: Own computation from experimental data

Note: * Percentage shares are calculated for each game level, where 100 FCFA is the lowest and 5000 FCFA is the highest game level. A total of 362 households participated in all the games.

The share of responses falling into the intermediate and moderate risk aversion categories remain approximately roughly stable between games 1 to 2 (52 percent and 54 percent), but decline to 46 percent in game 3 due to increases in the severe and extreme risk aversion categories. These results seem to indicate increasing partial risk aversion in which individual farm households are more risk averse as the size of the game increases.

Similar games have been played with peasant farmers in other areas in the developing world since the first field experiments by Binswanger (1980) with Indian farmers. Table A.4 in Appendix compares results from applying Binswanger's general experimental methods in farming communities in the Phillipines (Sillers 1980), Zambia (Wik and Holden, 1998) and Ethiopia (Yesuf, 2007). To facilitate comparisons among the experiments and to give a sense of the experimental pay-offs in terms of local incomes, all pay-offs were expressed in experiment-specific «daily wage» (DW) units following Wik and Holden (1998). This is equal to the daily wage received by an unskilled agricultural labourer in the study area in question. These results

are shown together with our results from Côte d'Ivoire⁷. Comparing our results to the Ethiopian, Zambian and Indian experiments, we found the proportion of farmers falling in the extreme to severe risk category to be higher in the Ethiopian experiment, but lower in the Zambian and Indian case. These results suggest that farm households in Côte d'Ivoire are less risk averse than in Ethiopia but are much more risk averse than in Zambia and India.

6.1.2. RESULTS OF THE ORDERED LOGIT MODEL

This section presents estimation results on the determinants of risk aversion. The results of the ordered Logit model are given in Table A.5 in Appendix where the dependent variable is the respondent's risk aversion category (1 "extreme risk aversion" to 6 "risk preferring"). To correct for possible heteroscedasticity, the White estimator of variances (White, 1980; StataCorp, 2001) is used, instead of the

⁷ Average daily wage rate in rural area in Côte d'Ivoire was 333 FCFA per day.

conventional ML variance estimator. The reported standard errors are, therefore, robust standard errors. First of all, a note of caution is warranted about interpretation of the results in an ordered model. In our ordered Logit model, the dependent variable is an order (rank) of risk aversion where extreme risk aversion takes rank number one (1) and risk-loving is indicated by rank number six (6). Therefore, a positive coefficient sign indicates a reduction in the degree of risk aversion. However, the coefficient does not provide an indication of the magnitude of the effect⁸. The Wald Chi-Square test that at least one of the predictors' regression coefficients is not equal to zero in the model, which is a measure of the overall goodness of fit of the model, provides evidence of a strong fit (p-value of 0.000) in the three regressions. The least value of the Pseudo R² is 0.13, an acceptable value in (cross-sectional) studies like these. In general, most variables have a significant effect and the coefficients have the expected signs particularly at low game level. These relationships however become weaker when the sums at stake are higher. This is not surprising because, as we can see from Table 4 above, the distribution of risk aversion is more concentrated at the highest game level (5000 FCFA) than at the 100 FCFA and 1000 FCFA game levels.

Effect of wealth on risk aversion

All the wealth indicators (farm income, value of livestock) are significant and have the expected negative effect on risk aversion (i.e. positive sign in the ordered Logit results), particularly at low stake indicating that more wealth is indeed correlated with a lower degree of risk aversion. This result is consistent with the literature and the DARA hypothesis. The presence of DARA indicates the existing significant difference in risk behaviour between relatively poor

and wealthy farm households. At higher game level (5000 FCFA), these wealth variables do not appear to affect risk aversion behaviour at all. Hence, for large-scale agricultural investments (where the amounts of money at risk are important), farmers' level of wealth could not influence their risk behaviour. Other factors like the perceived riskiness of the investment, its profitability, etc, could be more important in explaining farmers' decisions in such a case.

Effect of household and household head characteristics on risk aversion

The effects of the second group of independent variables on farmers risk behaviour are mixed. Parameters estimates on matrimonial status and household size are not statistically significant to explain farmers' degree of risk aversion at all game levels. With respect to household size, this finding is contrary to Wik and Holden (1998) results from Zambia where they found household size to be significant and negatively correlated with risk aversion. But our result is in line with the Ethiopian study by Yesuf (2007) who found an insignificant effect of household size in the total sample.

However, we found age to be highly correlated with level of risk aversion. The coefficient is always negative (positive relationship) at all game levels, indicating that older farmers are always more risk averse than younger farmers, regardless of the scale and size of investment in a project. This result is consistent with many studies (Belaid and Stanley, 1987; Brüntrup, 2000; Gomez-Limon et al, 2002; Yesuf, 2007). Education has been found to affect risk aversion negatively. This is in line with our expectation and the result of Yesuf (2007). In line with Wik and Holden (1998) and Yesuf (2007), we also found risk aversion to be significantly related to gender of the

⁸ The magnitude of the effect is provided by the marginal effects.

farmer where male heads are less risk averse than female heads as we expected. Whether the farmer is a native or a migrant also has an impact on his/her degree of risk aversion. At low game level (100 FCFA), we found a significant and negative relationship between being a native and the farmer's degree of risk aversion. This means that native people, relative to migrants from Côte d'Ivoire, migrant1 (the reference modality), are less risk averse (because of the positive sign). Considering migrants from neighbouring countries migrant2, the results show an insignificant relationship with risk aversion at low game levels (100 FCFA and 1000 FCFA). However, at higher game level (5000 FCFA), we found a significant positive relationship. Relative to Ivorian migrants, foreign farmers are more risk averse. This makes sense considering the existence of recurrent land ownership disputes faced by foreign farmers. They might therefore view large scale investments in their farm activity as more risky.

A significant parameter estimate on farmer dependence on cocoa revenue is only observed at the lowest level of the game (100 FCFA). Consistently insignificant through the last two games, we found level of cocoa dependence to be significant and negatively correlated with risk aversion in the first game. It means that the more the farmer's dependence in cocoa revenue, the less his/her degree of risk aversion. This is an unexpected result as we hypothesized farm household with high dependence on cocoa revenue to be more risk averse.

Effect of previous luck on risk aversion

As expected, we found a highly significant negative relationship between prior success and degree of risk aversion, as indicated by a significant positive coefficient estimate for the previous luck variables. Our result is in line with findings by Binswanger

(1980), Wik and Holden (1998) and Yesuf (2007) who found this variable to be highly significant and negatively correlated with risk aversion. This implies that people revise their expectations as the game level progresses even if the actual probability of success remains constant (coin toss). Similar behaviours could also be observed in actual farm investment decisions where farm households who had encountered a series of droughts may be more reluctant to undertake risky investment decisions, at least for a while, even when probabilities and wealth levels are unchanged throughout those periods

6.2. UNDERSTANDING THE DEMAND FOR MINIMUM PRICE INSURANCE

6.2.1. INTEREST IN MINIMUM PRICE INSURANCE: THE PROBIT SELECTION RESULTS

Before turning to the interpretation of the results of the Probit selection equation, we present the expressed interest of farmers in minimum cocoa price insurance, after it was explained to them how it would work (see Table A.6 in Appendix). From this table, it can be seen that 66% of the head of cocoa producing households indicated that they were interested in minimum price insurance. For those who declared that they were not interested in minimum price insurance (about 44%, which represent 123 heads), the reasons of negative response included: (1) lack of confidence in insurance system, (2) limited financial capability, (3) do not care about price volatility and (4) do not know how to answer.

The results of the Probit selection equation are presented in Table 5 below. Diagnostic statistics showed that the model had a good fit with chi-square test statistics significant at 1%. This shows that the

explanatory variables are relevant in explaining the adoption decision. Another measure of goodness of fit is the pseudo R². The value of 0.1250 is reasonable considering that the data for the study were obtained from cross-sectional survey of selected individuals from the study area.

The results show that household size has a significant and negative effect on farmers' desirability of minimum price insurance. This result should not be surprising and points out the fact that a larger family could represent an increased labour force for the household and thus reducing household's vulnerability to price volatility. Farming experience has been found to be significantly and positively correlated to the demand for minimum price insurance up to a certain threshold after which the relationship become negative. Another important variable significantly related to the demand for price insurance is the monetary value of livestock. As an asset, an increase in the value of livestock leads to an increase in farmers' financial capability and thus increases their probability to buy price insurance.

We find a significant and positive relationship between age of cocoa farm and insurance take-up decisions. This result can be explained by the fact that as the cocoa farm ages, output begins to decline and most farmers become more vulnerable to price fluctuations. The minimum cocoa price received over the five past years has also been found to affect farmers' demand for minimum price insurance. The higher the minimum price received, the less respondents are interested in price insurance.

Considering the risk management variables, we find that households who use assistance from social network are more likely to take up price insurance. This result seems counter-intuitive as participation in social networks can serve as buffer against future declines in cocoa prices. However, through the social network, farmers may learn insurance knowledge from people who was exposed to more information or have a better understanding of such products, or they can be influenced by other people's decisions.

Finally, the study reveals the importance of risk aversion as a significant determinant of farmers' demand for insurance. Compared to the omitted outcome (medium risk aversion), high risk aversion negatively affects the demand for insurance while low risk aversion increases the likelihood of farmers to take up the insurance. This result is not consistent with the theory of insurance demand which predicts that risk averse households will voluntarily purchase insurance if it can be offered to them. One plausible explanation for this unexpected result is the lack of confidence in the insurance policy. The liberalisation of the cocoa sector in Côte d'Ivoire in 1999 has exposed farmers to great uncertainties and misery in such a way that make them very prudent with all the new initiatives coming in the sector. Indeed, although detail description of how a minimum price insurance contract works has been presented to them, highly risk averse farmers could have limited trust in the credibility of the insurer and this is likely to hamper their insurance demand.

Table 5: Probit selection regression concerning interest in minimum price insurance (n=362)

Explanatory Variable	Coefficients	Standard Error	P-Value
Constant	0.228	0.693	0.742
Household and Head characteristics			
Education	0.184	0.160	0.249
Household size	-0.025**	0.012	0.034
Experience	0.101**	0.041	0.014
Experience2	-0.002**	0.000	0.019
Access to information	-0.200	0.174	0.252
Asset and credit constraint			
Value of livestock	4.46e-07***	1.61e-07	0.006
Farm size	-0.031	0.030	0.304
Farm size2	0.001**	0.000	0.046
Share_cocoa income			
Share<50%	-0.427*	0.241	0.076
Share>90%	-0.026	0.173	0.880
Age of cocoa farm	0.012***	0.004	0.009
Credit	-0.121	0.167	0.467
Risk Indicators			
High risk aversion	-0.430***	0.162	0.008
Low risk aversion	0.636*	0.365	0.082
Price variability dummy	0.418	0.256	0.103
Minimum price received	-0.002**	0.001	0.018
Existing risk coping strategies			
Social network	0.315*	0.170	0.065
Savings	-0.199	0.161	0.218
Crop diversification	0.094	0.201	0.639
Location Dummies			
Zone 1	0.152	0.221	0.492
Zone 3	0.495**	0.220	0.025
Number of obs.	= 362	Wald chi2 (22)	= 61.12
Pseudo R2	= 0.1250	Prob > chi2	= 0.000

***, **, * = significant at 1%, 5% and 10%, respectively.

Table 6: WTP Probit regressions results (all coefficients shown are the marginal effects)

Explanatory Variables	Minimum Price Insurance Contracts					
	400 FCFA Contract		600 FCFA Contract		800 FCFA Contract	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Bid values ⁹	-0.007***	0.002	-0.003***	0.000	-0.002***	0.000
IMR	0.176*	0.106	0.390*	0.235	0.347*	0.209
Asset and credit constraint						
Value of livestock	1.67e-03*	0.001	2.52e-03**	0.001	3.57e-03*	0.002
Farm size	0.002	0.008	0.006	0.008	0.004	0.007
Farm size ²	-0.000	0.000	-0.000	0.000	-0.000	0.000
Share_cocoa income						
Share<50%	-0.039	0.108	-0.106	0.100	-0.123	0.096
Share>90%	0.050	0.078	0.021	0.077	0.031	0.075
Age of cocoa farm	0.001	0.002	0.003	0.002	0.004*	0.002
Credit	-0.066*	0.037	-0.073*	0.043	-0.122*	0.070
Household and Head characteristics						
Education	0.115*	0.062	0.122*	0.069	0.112*	0.066
Household size	-0.011*	0.006	-0.012*	0.006	-0.000	0.006
Experience	-0.001	0.023	0.006	0.021	-0.003	0.021
Experience ²	-0.000	0.000	-0.000	0.000	0.000	0.000
Access to information	-0.095	0.080	-0.088	0.077	0.059	0.076
Risk Indicators						
High risk aversion	-0.192**	0.084	-0.147*	0.085	-0.171**	0.078
Low risk aversion	0.184	0.153	0.119	0.156	0.029	0.161
Price variability dummy	0.200**	0.092	0.271***	0.066	0.194**	0.084
Minimum price received	-0.001**	0.000	-0.000	0.000	-0.000	0.000
Existing risk coping strategies						
Social network	0.021	0.078	0.080	0.079	0.044	0.079
Savings	-0.066	0.077	-0.093	0.075	-0.066	0.071
Crop diversification	0.176**	0.076	0.104	0.077	-0.035	0.072
Number of obs.	239		239		239	
Pseudo R ²	0.1429		0.1413		0.2126	
Wald chi2(22) (Prob >chi2)	47.02 (0.0015)		52.69 (0.0003)		67.12 (0.0000)	

***, **, * = significant at 1%, 5% and 10%, respectively.

⁹ The results reported for "bid values" represent the estimates for three different variables (bid1, bid2, bid3). Results for bid1 (proposed bids for the 400 FCFA minimum price contract) are shown in the first two columns, results for bid2 (proposed bids for the 600 FCFA minimum price contract) are shown in the second two columns, and results for bid3 (proposed bids for the 800 FCFA minimum price contract) are shown in the last two columns.

Education also plays a statistically significant role on farmers' WTP decisions. The marginal coefficient of the education variable shows that holding all other variables at their means, being literate increases the WTP of the respondent by 11.5% for the contract paying 400 FCFA as minimum price, by 12.2% for the contract paying 600 FCFA as minimum price and by 11.2% for the contract paying 800 FCFA as minimum price. More educated farmers may be more skilled on accessing and assimilating information about how price insurance works as well as its advantages. Like in the Probit selection equation, we observe again a significant negative effect of household size on household's WTP for insurance. The effect of risk aversion is negative and statistically significant in explaining farmers WTP for minimum price insurance. Highly risk averse farmers were willing to pay 4.2% to 17.1% less to purchase price insurance than farmers with medium risk aversion. Though insignificant in the interest equation, price variability dummy positively affect the WTP in the three Probit equations.

One of the basic objectives of CV studies is to provide a summary measure of the WTP of respondents. However, in discrete choice models, this task may not be straightforward since the amount respondents are willing to pay is not directly observed. In this study, we cope with this difficulty by asking open questions on farmers' WTP for each minimum price contract. Table A.7 in Appendix indicates the summary statistics of the individual WTP values. Considering the whole sample, the results indicate that cocoa producers that are interested in minimum price insurance are willing to pay 8.5%, 10.48% and 13.42% of the underlying contract value as premium, respectively for minimum price insurance at 400 FCFA, 600 FCFA and 800 FCFA. This is relatively low compared to others studies like the one by Sarris et al. (2006) for the case of Tanzania where farmers were willing to pay between 13 and 30% of the option value. The results also

reveal that cocoa producers in Zone 2 that are interested in minimum price are willing to pay on average between 10.73 and 14.7% of the underlying contract value while farmers in Zone 1 and Zone 3 that are interested in minimum price are willing to pay less. On average, for Zone 1 and Zone 3, respondents are willing to pay respectively between 9.5 and 13.98% and between 5.7 and 11.8% of the underlying contract value.

7. SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

This paper is intended to contribute to the ongoing debate on agricultural risk management in developing countries by providing empirical evidence on Ivorian cocoa farmers' risk aversion and the determinants of producers' potential demand for minimum price insurance. Using an experimental gambling approach with real payoffs, as well as a CV method, we find a relatively high level of risk aversion among Ivorian cocoa farmers. Explicitly, the experimental results show an inclination of farm households to be more risk averse as the level of the game increases, with more than 45 percent of the households exhibiting severe to extreme risk aversion at the highest level of the game. Moreover, in analysing the determinants of farmers' risk aversion, the empirical finding that wealthier farmers are more risk taking is confirmed by this study. This result then is consistent with the literature and supports the DARA hypothesis. Our results also points out that younger, educated, male, native farmers exhibit lower levels of risk aversion. Finally, the econometric analysis of risk aversion reveal that farmers who have experienced some previous luck in the past, tend to be less risk averse than the others.

Using 5-point Likert scale, we found perceptions on risk sources to be very personal and specific across cocoa farmers. However, farmers were relatively in

agreement when evaluating the impacts of some sources of risks: the majority of the farmers ranked output price risk as the most important source of risk. This appears to induce considerable interest in minimum price insurance with 66 percent of farmers responding positively to the interest question. From the econometric analysis, it appears that farmers' demand for insurance is affected by a range of independent variables like household size, farming experience, monetary value of livestock, share of cocoa in total income, age of cocoa farm, farm size and social network as coping mechanism. More importantly, we find a highly significant effect of risk aversion on farmers' insurance take-up decisions. In particular, high risk aversion has been found to inhibit the demand for insurance; as a result of limited trust in the credibility of the insurance policy. Furthermore, the WTP analysis reveals that farmers' individual WTP for minimum price insurance are relatively low. Households are on average willing to pay between 8.5 and 13.42 percent of the option value they will receive as a premium depending on the option value.

Based on the results from this study, particular attention should be given to the effects of risks on rural households' behaviour. From the policymaker's perspective, it is essential to consider farmers' risk aversion in the formulation and implementation of rural development policies, and understand how to reduce the riskiness of rural incomes through the provision of viable insurance mechanism. The following recommendations should therefore be considered:

Whether in technology development or for policy formulation, the risk aversion of farmers must be taken into account. For example agricultural extension should start modestly by investments with high probability of success before asking households to take on larger investments involving higher degree of risk in terms of loss in agricultural income. Because farmers' level of

risk aversion decreases with past successes, this way, we ensure that they will be less reluctant to undertake larger investments.

In line with the substantial demand for cocoa price insurance within farmers, policies should address the individual barriers and design problems that have been identified as disincentives to farmer participation in insurance program, while taking measures to organize and coordinate resources to achieve its operational effectiveness. In particular there is need for economic empowerment of both male and female farmers to improve their WTP and adoption of the scheme. More importantly, farmers should be convinced of the reliability and the credibility of the insurance provider.

A major focus should be on community education, in order to reduce farmers' risk aversion and equip them with the skills to understand the role of agricultural insurance as a key tool to deal with risks. Sustainability of the scheme should be ensured by educating farmers to integrate its operation within their livelihood objectives and cultural norms.

Farmers' organizations should be strengthened to better serve farmers in providing information on modern risk management instruments.

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APPENDICES

Figure A 1: Bas-Sassandra region



Figure A2: Soubré, the study department

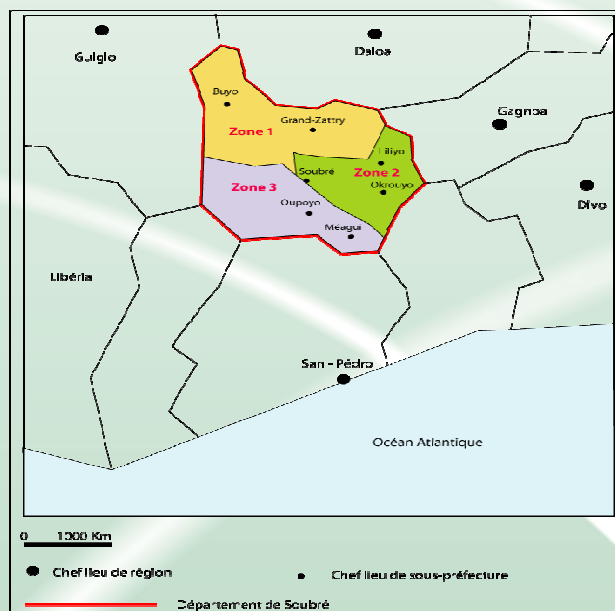


Table A.1: Risk Preferences games

Game 1: 100 FCFA game (real)

Choices	Bad Outcome “Heads”	Good Outcome “Tails”	Expected Gain =E	Standard deviation =SE	Risk classification
O	100	100	100	0	Extreme
A	90	180	135	45	Severe
B	80	240	160	80	Intermediate
C	60	300	180	120	Moderate
D	20	380	200	180	Slight to Neutral
E	0	400	200	200	Neutral to Preferring

Game 2: 1000 FCFA game (real)

Choices	Bad Outcome “Heads”	Good Outcome “Tails”	Expected Gain =E	Standard deviation =SE	Risk classification
O	1000	1000	1000	0	Extreme
A	900	1800	1350	450	Severe
B	800	2400	1600	800	Intermediate
C	600	3000	1800	1200	Moderate
D	200	3800	2000	1800	Slight to Neutral
E	0	4000	2000	2000	Neutral to Preferring

Game 3: 5000 FCFA game (hypothetical)

Choices	Bad Outcome “Heads”	Good Outcome “Tails”	Expected Gain =E	Standard deviation =SE	Risk classification
O	5000	5000	5000	0	Extreme
A	4500	9500	7000	2500	Severe
B	4000	12000	8000	4000	Intermediate
C	3000	15000	9000	6000	Moderate
D	1000	19000	10000	9000	Slight to Neutral
E	0	20000	10000	10000	Neutral to Preferring

Table A.2: Regressors used in Ordered Logit model and expected sign (n=362)

Variables		Description	Expected Sign
INDEPENDENT VARIABLES IN THE ORDERED LOGIT MODEL	Wealth Indicators		
	<i>Farm income</i>	Total annual farm income of household head (in FCFA)	-
	<i>Value of livestock</i>	Economic value of livestock (in FCFA)	-
	Household Characteristics		
	<i>Age</i>	Age of the household head	?
	<i>Education</i>	Dummy=1 if head of household is literate	
	<i>Gender</i>	Dummy=1 if head of household is a male	-
	<i>Origin</i>		
	Native	Dummy=1 if head of household is native of Soubré	-
	Migrant1	Dummy=1 if head of household is migrant from Côte d'Ivoire	+
	Migrant2	Dummy=1 if head of household is migrant from another country	+
	<i>Matrimonial status</i>	Dummy =1 if head of household is married	+
	<i>Household size</i>	Total number of people in the household	?
	<i>Level of dependence in cocoa revenue</i>	Categorical variable taking values 1: < 70% dependence, 2: from 70 to 90% dependence and 3: 100% dependence on cocoa revenue	+
	Game variable		
	<i>Previous luck</i>	Dummy variable defined as $\sum X_i$, and X takes the value of 1 when the person wins (tails), -1 when he loses (heads) and 0 when neither wins nor loses (alternative O)	-
	Location		
	<i>Zone 1</i>	Dummy=1 if household lives in Zone 1	?
	<i>Zone 2</i>	Dummy=1 if household lives in Zone 2	?
	<i>Zone 3</i>	Dummy=1 if household lives in Zone 3	?

Source: Author

Table A.3: Descriptive statistics of variables used in the Heckman two-step model

Variables		Explanation	Mean	Std. Dev
DEPENDENT VARIABLES	<i>Interest</i>	Dummy = 1 if the producer take-up price insurance, and 0 otherwise	0.6602	0.4742
	<i>400 F Contract</i>	Dummy = 1 if the producer is willing to accept the 400 FCFA minimum price contract for the proposed bid, 0 otherwise	0.3640	0.4821
	<i>600 F Contract</i>	Dummy = 1 if the producer is willing to accept the 600 FCFA minimum price contract for the proposed bid, 0 otherwise	0.3472	0.4771
	<i>800 F Contract</i>	Dummy = 1 if the producer is willing to accept the 800 FCFA minimum price contract for the proposed bid, 0 otherwise	0.3263	0.4698
INDEPENDENT VARIABLES	Bid Values			
	<i>Bid1</i>	Bids for the 400 FCFA minimum price contract	50.3729	18.3928
	<i>Bid2</i>	Bids for the 600 FCFA minimum price contract	97.0994	40.9193
	<i>Bid3</i>	Bids for the 800 FCFA minimum price contract	178.8674	63.0665
	Household and Head Characteristics			
	<i>Education</i>	Dummy = 1 if head of household is literate	0.4254	0.4950
	<i>Household size</i>	Total number of people in the household	12.6132	7.0278
	<i>Experience</i>	Number of years the household head has been engaged in cocoa production	22.0745	7.4805
	<i>Information</i>	Dummy=1 if household own a radio/TV	0.7375	0.4405
	Asset and Credit Constraint			
	<i>Value livestock</i>	Monetary value of livestock (in FCFA)	252665.7	798711.9
	<i>Farm size</i>	Size (in hectares) of land used by the household for cocoa production	7.5540	10.8632
	<i>Share<50%</i>	Share of cocoa income in total income less than 50%	0.1298	0.3365
	<i>Share 50-90%</i>	Share of cocoa income in total income between 50% and 90%	0.3867	0.4876
	<i>Share>90%</i>	Share of cocoa income in total income more than 90%	0.4834	0.5004
	<i>Age cocoa farm</i>	Age of cocoa farm in years	15.1298	25.1135
	<i>Credit</i>	Dummy =1 if head of household has benefited from any kind of credit (formal/informal) in the past year	0.4723	0.4999
	Risk Indicators			
	<i>High risk aversion</i>	Dummy=1 if head of household fell into extreme to severe risk categories	0.3287	0.4704
	<i>Medium risk aversion</i>	Dummy=1 if head of household fell into intermediate to moderate risk categories	0.5386	0.4991
	<i>Low risk aversion</i>	Dummy=1 if head of household fell into neutral to preferring risk categories	0.1325	0.3396
	<i>Price variability</i>	Dummy = 1 if head of household perceived fluctuation in cocoa price as the first major risk	0.6878	0.4640
	<i>Minimum price</i>	Minimum cocoa price received over the past five years (in FCFA)	281.4779	69.4803
	Existing Risk Coping Strategies			
	<i>Social network</i>	Dummy =1 if the producer use social network as risk coping strategy, 0 otherwise	0.4281	0.4954
	<i>Saving</i>	Dummy =1 if the producer use savings as risk coping strategy, 0 otherwise	0.5745	0.4950

<i>Crop diversification</i>	Dummy =1 if the producer use crop diversification as risk coping strategy, 0 otherwise	0.3287	0.4704
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Source: Own computation from survey

Table A.4: Percentage distribution of revealed risk preferences in five experimental studies

<i>Games</i>	Extreme to Severe risk aversion	Intermediate to Moderate risk aversion	Risk-neutral to Risk- preferring	Number of response s
<i>India (Binswanger, 1980)</i>				
50 Rupee (14.3 DW)	8.4	82.2	9.4	(107)
500 Rupee ^H (143 DW)	16.5	82.6	0.9	(115)
<i>Philippines (Sillers, 1980)</i>				
50 Peso (7.1 DW)	10.2	73.5	16.3	(49)
500 Peso (71 DW)	8.1	77.6	14.3	(49)
<i>Zambia (Wik and Holden, 1998)</i>				
1000 Kw (1.8 DW)	29.1	46.4	24.5	(423)
10000 Kw ^H (18 DW)	36.7	52.5	11.0	(137)
<i>Ethiopia (Yesuf, 2007)</i>				
5 Birr (0.5 DW)	45.4	33.6	21	(262)
15 Birr ^H (1.5 DW)	55.7	27.5	16.8	(262)
<i>Côte d'Ivoire</i>				
1000 FCFA (3.0 DW)	32.88	53.87	13.26	(362)
5000 FCFA ^H (15.0 DW)	46.13	45.86	8.01	(362)

Source: Author adaptation from Wik and Holden, 1998

^H: Hypothetical game

Table A.5: Ordered Logit models of Risk Aversion per game level (n=362)

Variables	100 FCFA		1000 FCFA		5000 FCFA	
	Coef.	Std. Err	Coef.	Std. Err	Coef.	Std. Err
Wealth Indicators						
<i>Farm income</i>	1.40e-7**	5.78e-8	1.22e-8	9.46e-8	-1.11e-7	6.85e-8
<i>Value of livestock</i>	2.12e-7***	7.09e-8	2.32e-7**	9.96e-8	1.65e-7	2.17e-7
Household/Head Characteristics						
<i>Age</i>	-0.047***	0.010	-0.027***	0.009	-0.018*	0.010
<i>Education</i>	0.516**	0.238	0.586**	0.229	0.293	0.215
<i>Sex (Male)</i>	1.668***	0.580	1.423***	0.367	1.338***	0.495
<i>Origin⁺⁺</i>						
Native	0.910***	0.309	0.302	0.281	-0.360	0.309
Migrant2	0.396	0.254	0.257	0.254	-0.417*	0.245
<i>Matrimonial status</i>	-0.272	0.268	-0.182	0.300	0.067	0.322
<i>Household size</i>	0.006	0.014	-0.021	0.017	-0.022	0.015
<i>Dependence in cocoa</i>	0.516**	0.237	-0.173	0.238	-0.213	0.237
Game variable⁺⁺⁺						
<i>Luck1</i>	--	--	0.292***	0.111	--	--
<i>Luck12</i>	--	--	--	--	0.289***	0.079
Location⁺⁺						
<i>Zone 1</i>	-0.607**	0.264	-0.229	0.255	-0.444*	0.232
<i>Zone 3</i>	-0.654**	0.280	-0.581**	0.296	-0.666***	0.275
Threshold parameters						
<i>Cut1 (α_1)</i>	-2.805	0.700	-2.131	0.559	-1.98	0.658
<i>Cut2 (α_2)</i>	-1.919	0.711	-1.001	0.539	-0.377	0.644
<i>Cut3 (α_3)</i>	-0.335	0.707	0.543	0.530	1.118	0.643
<i>Cut4 (α_4)</i>	0.786	0.703	1.852	0.543	2.400	0.661
<i>Cut5 (α_5)</i>	2.017	0.710	2.709	0.567	3.268	0.709
Log likelihood function	-573.871		-567.268		-540.557	
Wald Chi-Squared	84.42		67.99		56.18	
P-value	0.000		0.000		0.000	
Pseudo R2	0.20		0.14		0.13	
Number of observations	362		362		362	

Dependent variable: degrees of risk aversion (1=Extreme,...,6=Neutral to Risk Loving).

⁺ This refers to the 100 FCFA game with gains and losses.

⁺⁺ Migrant1 is the reference for Origin and Zone 2 is the reference for Location.

⁺⁺⁺ Luck1 is the luck from game1 (100 FCFA game with only gains); Luck12 is combined luck from game1 and game2 (1000 FCFA game).

***, **, * indicate significance levels at 1%, 5%, and 10% levels, respectively.

Table A.6: Interest in minimum price insurance among cocoa producing households (n=362)

Zone	Interest in Minimum Price Insurance (%)		
	YES	NO	Total
Zone 1	23.20	13.26	36.46
Zone 2	19.34	13.53	32.87
Zone 3	23.48	7.2	30.66
Total	66.02	33.98	100

Source: Authors' calculations

Table A.7: Mean WTP for each minimum cocoa price insurance contract (in FCFA)

Zone	400 FCFA		600 FCFA		800 FCFA	
	WTP (Mean)	WTP (Share of 400FCFA min. price)	WTP (Mean)	WTP (Share of 600FCFA min. price)	WTP (Mean)	WTP (Share of 800FCFA min. price)
Zone 1	37.97	9.5%	70.23	11.7%	111.90	13.98%
Zone 2	42.92	10.73%	73.5	12.25%	117.64	14.7%
Zone 3	22.76	5.7%	46.88	7.8%	94.35	11.8%
Total	34.01	8.5%	62.88	10.48%	107.34	13.42%