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Risk experiments in gains and losses

A case study for Benin

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Abstract

The aim of this paper is to expand our knowledge on risk aversion among the poor by conducting experiments that do not only test risk aversion in small and large stakes but also in risky gains and risky losses. To our knowledge, this is the first attempt to conduct experiments in poor communities strictly focused on the loss domain. The experiments were conducted with 120 poor rural households in Benin. In contrast to results in industrialized countries, we find that playing lotteries constrained to the loss domain dramatically increases risk aversion. We also find a strong negative relationship between the level of risk aversion (both in gains and losses) and the level of religious faith. Our interpretation of this result is that villagers with strong beliefs tend to rely more on God's goodwill at the expense of a proper risk assessment, resulting in larger risk-taking.

Keywords: risk aversion, loss aversion, religion

JEL classification: D81, O1

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1 Introduction

Risks play a crucial role in decision-making and well-being both in developing as well as in industrialized countries. Yet, the exposure to negative shocks is more exacerbated in developing countries because of the lack of dedicated markets that would allow for risk hedging, whether they are contingent markets (forward and future contracts) or insurance solutions. Moreover, without those markets it is extremely difficult to determine risk aversion, or the price people are willing to pay to remove negative risks from their daily life.

An extensive literature has therefore emerged which aims to empirically elicit risk preference parameters in developing countries (Antle 1987; Bardsley and Harris 1987; Bar-Shira et al. 1997). The problem is that econometric techniques suffer from their inability to disentangle pure risk aversion from budget constraints, time preferences and limited hedging strategies, often resulting in an overestimation of risk aversion of poor people (Binswanger 1982). To circumvent this problem, Dillon and Scandizzo (1978) and Binswanger (1981) initiated field experiments using budget- and time-neutral lotteries to elicit risk preferences among the population of several developing countries. Our study follows their approach but extends the experiments along two important dimensions, which have so far been neglected in the literature, and which we motivate in detail below: (1) capturing risk preferences not only in games of positive outcomes but also in situations of pure losses, and (2) improving the quality of the estimated risk aversion parameters by reducing the possible cognitive bias (lack of understanding) associated with the usually applied lottery selection procedure.

To our knowledge, this is the first attempt to conduct games in poor communities strictly focused on the loss domain (each lottery alternative resulting in a loss). Apart from Yesuf and Bluffstone (2009) who introduced lotteries of gains-and-losses and compared them to the traditional gain-only lotteries, the change in risk preferences when the context shifts from pure gains to pure losses remains unknown for rural and poor settings. Such an analysis is, however, crucial on a theoretical as well as on a practical ground to better understand individuals' behaviours in situations of risky losses.

From a policy point of view, it remains unclear if the risky behaviours that are often observed among the rural poor when it comes to risky losses are the consequence of a preference for risks in losses, a consequence of having time preferences skewed towards the present (large discount rates), an incapacity to pay for the price to mitigate the risk (budget constraints), or a lack of mitigation strategies (or a combination of either factor). Taking the example of malaria and mosquito nets, where households across countries have been shown to invest very little in mosquito nets (Cohen and Dupas 2010) despite their proven protective effects against malaria (Erlanger et al. 2004), raises the question whether households do not invest in mosquito nets because they are risk seekers when it comes to health costs, or whether any other of the explanations discussed above holds. Knowing what are the main drivers behind suboptimal hedging is important to design improved mitigation strategies against such risks. The worst-case scenario for governments and developing agencies would be to target policies towards riddance of budget constraints and improved access to risk mitigating measures, only to discover that poor households are risk-seekers when it comes to losses. Estimating preferences for negative risks and the key socio-economic variables that are associated with them is therefore necessary to prioritize development interventions.

From a theoretical perspective, understanding risk preferences in losses is an attempt to bridge the gap between the extensive prospect theory literature that has emerged in industrialized countries and research on risk preferences in developing countries. Since the pioneering work of Kahneman and Tversky (1979), it has been shown that people do not always behave along the lines of expected utility theory. Instead of evaluating risks and returns on the basis of final wealth, people tend to have reference points that influence what they consider as a gain and what they consider as a loss. This distinction is important since most people tend to value a loss higher than its symmetrical gain, and tend to show risk seeking behaviour in losses despite being risk averse in gains.[1] Empirically, several attempts have been made to compute risk aversion coefficients within a prospect theory framework (Harrison et al. 2005, Galarza 2009) but their complexity prevents them from being used outside of well-educated populations. Conscious of this limitation, our approach is to test for risk preferences in loss-only lotteries but using a calibration that still relies on expected utility theory. Statistically significant deviations between loss-only and their gain-only lottery counterparts will support the idea that poor rural people (at least within our sample) also show certain characteristics of prospect theory.

Second, we try to improve on the estimated risk aversion parameters by designing experiments that make ‘sense’ to poor rural populations. Across the literature, most risk aversion elicitation procedures involve the selection of one lottery among a set of comparable lotteries (most often six or seven), on the basis of their varying expected means and variances. While this approach is perfectly valid on a theoretical ground, it has in our opinion two severe limitations. It is first of all a purely hypothetical exercise with no comparable real-life application, and individuals have difficulties relating such a choice to anything of their daily life. For example, it rarely occurs that individuals are presented with a win-win situation, with only different risk levels involved. Second, the cognitive effort requested to compare different lotteries on their mathematical terms seems too demanding for populations with limited educational backgrounds. This limitation has already been acknowledged in numerous papers (Harrison et al. 2010; Schechter 2007; den Berg et al. 2009), which then relied on an elicitation procedure through pair-wise selections.[2] Unfortunately, a pair-wise approach can lead to inconsistency between choices. Our approach is to replace the process of comparing lotteries with a decision to invest in a single, risky lottery defined by a good state (with a multiplier greater than 1 of what is invested) and a bad state (equal to a zero pay-off). The cognitive requirement is hence lowered considerably: the participant is left with only one risky lottery and one unique multiplier.

In contrast to experiments from industrialized countries where individuals have shown to higher

[1]Another argument is the certainty effect proposed by Allais (1953): while on the gain domain, people tend to prefer a sure gain to a risky prospect, the effect reverses in the loss domain and enhances risk seeking behaviours.

[2]For a thorough review of the different methodologies, we refer the reader to Cox and Harrison (2008).

risk taking behaviours in losses than in gains (Libby and Fishburn 1977; Fennema and Assen 1998; Harbaugh et al. 2002), we find that playing lotteries constrained on the loss domain dramatically increases risk aversion in rural Benin. We also find a strong negative relationship between the general level of risk aversion (both in gains and losses) and the level of religious faith. A possible explanation is that individuals with strong beliefs tend to rely more on God's good will at the expense of a proper risk assessment, resulting in larger risk-taking. Moreover, whereas villagers display - in line with the literature - increasing partial risk aversion (IPRA), we find that larger wealth among generally poor individuals is negatively correlated with risk taking, indicating increasing absolute risk aversion (IARA). This contradicts most of the literature which generally assumes decreasing absolute risk aversion (DARA). We also observe that risky decisions are path dependent: while a previous win in a sequence of games leads to increased risk appetence, the experience of income shocks has the expected inverse effect of increased risk aversion.

The paper is structured as follows: section 1 presents the methodology and experimental design, followed by section 2 with the data and field description. Section 3 presents our descriptive and econometric analysis and section 4 concludes.

2 Methodology and experimental design

Despite various applications of the methodology designed by Binswanger (1980), eliciting risk aversion profiles in poor and low-educated communities remains a challenge. First, the often applied experimental design assumes a degree of mathematical proficiency which is rarely achieved by low-educated populations (despite the recent arguments made by Delavande et al. 2011). Concepts of mean and variance are sometimes difficult to convey, especially for individuals who have no experience with written numbers (while being good at mental calculation orally). Second, lotteries should be meaningful to individuals, i.e. related to real-life choices, since individuals - at least in our sample - always grounded choices in daily situations, whether implicitly or explicitly. To facilitate decision-making and avoid noise generation coming from cognitive impediment, our design strategy is to allow each villager to divide an initial budget between a 'safe' investment (or a sure loss) and a risky investment (or a risky loss) that takes the form of a binary lottery with fixed multipliers (positive or negative depending on testing for risk aversion in gains or losses). Contrary to the usual approach of asking players to choose a lottery based on two outcomes and eventually on its mean and variance, our method is very close to actual cognitive processes that are part of the daily life of villagers. While they rarely (or never) have to choose between different abstract returns with varying risks, individuals often have to decide on investments for which rewards are uncertain.

We use and pay out real money (in CFA francs) for each single game instead of theoretical numbers with payments only at the end of a series of games, which is frequently done. For individuals who often do not know the meaning of written numbers but are used to coins and bills (and their respective values) it limits errors and forces the participants to consider their decisions carefully.

To compare our results with the literature (e.g. Binswanger 1980; Yesuf and Bluffstone 2009), the participants are not allowed to choose their own allocation of 'safe' and risky investments but are provided with an initial set of six allocation options. The calibration of the allocation brackets is the result of a constant partial risk aversion (CPRA) coefficient elicitation using a utility maximizing approach where the participant optimizes his initial endowment in a two-fund portfolio (risk-free and risky), such that:

$$\max_{i} \alpha(1-\gamma)(I-i)^{(1-\gamma)} + (1-\alpha)(1-\gamma)((I-i)+\beta i)^{(1-\gamma)} \tag{1}$$

where I is the initial endowment, i is the the allocation of money in the risky bet, β is the multiplier for the risky investment, α is the probability for the risky game and γ is the CPRA coefficient. For α we use 0.5 throughout the games. The outcome is decided upon the toss of a coin by the participants. Using a coin with probabilities of 50/50 is both easy to explain and easy to implement. It also gives the player full responsibility over the outcome, ensuring that the participants trust the game and the outcome of the toss.

We use the same calibration approach for the loss domain with a slight adjustment that accounts for a negative multiplier for the risky investment and with j representing the amount at risk that can be reduced through a sure loss of i, leading to the following maximization problem:

$$\max_{i} \alpha(1-\gamma)(I-i)^{(1-\gamma)} + (1-\alpha)(1-\gamma)((I-i)-\beta(j-i)^{(1-\gamma)} \tag{2}$$

In contrast to equation (1), where a higher initial investment leads to a higher risky gain, in equation (2) a higher initial investment leads to a lower risky loss. If $i = 0$ ($i = I$) in equation (1) the participant walks away with a 'sure' low gain (a risky but high expected gain). If $i = 0$ ($i = j$) in equation (2) the participant walks away with a risky but high expected loss (a 'sure' low loss).

Table 1 presents our calibration for the games in the small-stake gain domain ('gain-only') and Table 2 the calibration in the small-stake loss domain ('loss-only'). The alternatives range from no investment into the risky investment option (highest risk aversion) to full investment into the risky investment option (risk neutral to loving) for the gain domain. For the loss domain the alternatives range from high investment to lower the amount at risk (highest risk aversion) to no investment to lower the amount at risk (risk neutral to loving). Each participant plays a series of four games in a pre-defined sequence: first a 'gain-only' game with small and then large prospects followed by a 'loss-only' game with small and finally large prospects. For the large stake games the initial endowment I and possible investments i presented in Table 1 and 2 were doubled.

The multipliers of the game are chosen in conjunction with the initial endowment to ensure that the games are self-sustaining, i.e they are not influenced by existing budget constraints. The initial endowments are chosen high enough in order to motivate villagers to participate and take the games seriously but low enough to prevent conflicts with the non-participating bystanders within the village. Games of losses are played with somewhat smaller endowments, again as a way to comply with the objective of self-sustainability and avoiding conflicts within the village. If anything, in a context of IPRA, we assume that lower stakes in losses would increase risk taking, something we do not observe in our results. 500 CFA represent an average daily wage for unskilled rural labour in the sampled villages.

Last, the investment choices of individuals were unfortunately influenced by the monetary context of Benin, which is heavily dependent on the African Central Bank for the supply of coins. This resulted in a shortage of small value change during our field experiments, forcing us to deviate, albeit slightly, from the optimal bracket calibration for our games for the extreme and severe risk classes. Considering that our results of the 'gain-only' games (see Figure 2), are well distributed and in line with similar games in the literature (Yesuf and Bluffstone 2009), we are confident that spill-over effects from the extreme to the severe brackets of risk aversion are not significant.

Table 1: Calibration for the gain-only games with small amounts

Choice	Invest. i	If tail (win)	If head (lose)	Expected risky gain	Standard deviation	Expected final position	CPRA coefficient (γ)	Risk class
1	-0	0	0	0	0	500	∞ to 7	Extreme
2	-25	75	0	37.5	53	512.5	7 to 3	Severe
3	-50	150	0	75	106	525	3 to 1.2	Intermediate
4	-150	450	0	225	318	575	1.2 to 0.5	Moderate
5	-350	1050	0	525	742	675	0.5 to 0.2	Slight
6	-500	1500	0	750	1061	750	0.2 to $-\infty$	Neutral to preferring
Endowment I (with a multiplier of 2):							500 FCFA	

Source: Authors' compilation

Table 2: Calibration for the loss-only games with small amounts

Choice	Invest. i	If tail (win)	If head (lose)	Expected risky gain	Standard deviation	Expected final position	CPRA coefficient (γ)	Risk class
1	-500	0	0	0	0	500	∞ to 7	Extreme
2	-475	0	-44	-22	31	503	7 to 3	Severe
3	-450	0	-88	-44	62	506.5	3 to 1.2	Intermediate
4	-400	0	-175	-87.5	124	512.5	1.2 to 0.5	Moderate
5	-250	0	-438	-219	310	531	0.5 to 0.2	Slight
6	0	0	-875	-437.5	619	562.5	0.2 to $-\infty$	Neutral to preferring
Endowment I (with a multiplier of -1.75):							1000 FCFA	

Source: Authors' compilation

Since this initial calibration does not provide the distinction between risk neutral preference and risk seeking behaviour, whenever a participant selected the largest investment in the risky bet, we asked him to play an additional hypothetical game where he had to choose between a risk-neutral lottery and a risk-seeking one.[3]

Before each game (hence four times), each participant receives an initial amount of money corresponding to each specific game (i.e. the amount I in equations 1 and 2). This serves the practical purpose of shielding the players from potential personal losses (in particular during the loss sequences) while motivating the players to stay until the end of the experiment. To conduct the full experiment, we asked the participants to stay with us for a full day at a time when the first days of rain required field work of the farmers. The game payments were therefore a fair compensation for the productivity loss with the monetary gain of participating in the experiments for one day being on average larger than a usual weekly income.

We assume for the purpose of our analysis that the players internalize the endowments provided by us within their available budget *before* we start playing. This is of course a strong assumption, albeit one commonly assumed (Harrison and Rutström 2008; Harbaugh et al. 2002). A valid criticism could be that the villagers, receiving some external income and being asked to play a monetary game right away, consider this new wealth as ‘game money’ (or ‘drink money’) and not as part of their current budget.[4] This limitation should, however, not influence the differences we find between small and large stake games and between gain and loss games.

This possible phenomenon of mental accounting (between the player’s own budget and the received endowments for playing the games) was impossible to get rid of in our context. A first solution would have been to ask people to play with their own money but this would have resulted in some people being poorer after the games, a situation we wanted to avoid at all costs considering their already difficult conditions. A second solution would have been to distribute the compensations beforehand and to play the games few days afterwards, giving the participants time to internalize this new wealth. This approach would, however, have introduced a time lag between the payment of the compensation and the games. In the best case, a lag means the introduction of a time-preference element that is outside the scope of our research and unaccounted for. In the worst case, it means that players are no longer motivated to participate and refuse to participate, or that villagers (with high discount rates) would already have spent (part of) the money for leisure activities and if participating would again have ended poorer than before the games.

In a next step, each participant is asked to put the received compensation (I) in front of him in a special box representing his budget.[5] Facing this budget box, a large Table with six separated investment areas (columns) and the potential pay-offs - representing the choices in Table 1 and 2 - is presented to the participant. Each investment column shows a small square with

[3]The procedure is similar to the rest of the experiments. The participant is required to select between a risk-neutral proposition and a risk-seeking one.

[4]This perception problem is probably amplified by the source of income, the interviewer, who adds some meaning to the monetary value of the compensation.

[5]We ensure that the compensation is paid with enough small change to allow for all possible investment options.

the possible investment *i* and a second area with printed change representing the added value in case of a gain. The participant is then asked to take the chosen investment amount from his budget (matching one of the six investment squares) and to put it on the investment square of the respective column. For the ‘gain-only’ games this investment represents the share he is willing to invest in a risky project. We match the selected option by putting real money change on the printed money for the selected option. The randomness of the outcome of the risky project is materialized by a coin that the player has to flip. Before flipping the coin the participant is asked to describe orally the potential pay-offs for the chosen alternative to make sure that he fully understands his investment choice. Upon the result of the flip, the final pay-off is settled immediately, before moving on to the next game. For the ‘loss-only’ games the interpretation is slightly different since an investment *i* in one of the presented investment columns represents a sure loss reducing the amount at risk.

3 Data and field description

The experiments were administered at the end of a large-scale panel household survey covering 2000 randomly selected households from 200 villages in two departments of Benin.[6] Despite recent economic and structural reforms that sustained a moderate growth rate in its per capita income up to US$750 per capita in 2009 (World Bank 2010), Benin remains a poor country, ranking 134th in the Human Development Index (out of 169 countries). From the 200 villages surveyed between January 2009 and July 2010, a sub-sample of 12 villages in the department of Collines was selected in August 2010 to conduct the experiments.[7] Collines relies mainly on agriculture, with both subsistence (maize, yam) and cash (cotton, cashew, sugar cane) crops, and on transit services to the neighbouring countries. The villages were selected to both represent the socio-economic diversity of the department but at the same time to represent the highest possible level of literacy using an aggregated index comprising years of schooling, highest degree achieved and fluency in French (the official language in Benin). The aim was to reduce the inevitable noise coming from an insufficient understanding of the games. We are, however, confident that this deliberate trade-off for more education does not create a large selection effect: the average completed years of schooling in the selected villages was still only 3 years and we observed large variation of education levels within the villages, covering the full distribution from no schooling to high school levels.

Table 3 presents some descriptive statistics of key socio-economic variables which were used as regressors in the econometric analysis in section 4 [8]. The average years of schooling is 2.94 years, with 20 per cent of the respondents having more than seven years or more of schooling.

[6]The study was financed by the Federal Ministry of Economic Cooperation and Development (BMZ) Germany, the German KfW Development Bank, and the Policy and Operations Evaluation Department (IOB)- Ministry of Foreign Affairs of the Netherlands. The financing and use of the 4th wave of this survey for complementing our experimental results is gratefully acknowledged.

[7]The villages were Adourekouman, Assromihoue, Bethel and Tankossi in the commune of Glazou, Agbomadin, Koutago, Lema, Lowozoungo, Mondji, Segbeya and Zongo in the commune of Savalou and Atchakpa and Gobé in the commune of Savé.

[8]Detail of their use is given in Annex 1

The average household size is just below six household members with a predominance of young children and with 10 per cent of the respondents coming from households with more than 10 individuals. A majority of the participants are farmers, followed by a group of artisan/merchants often representing housewives either selling excess productions on markets or working as dress-makers. A minimal number of participants is employed while the 'other' category covers students, trainees, unemployed and retired people. It was beyond the scope of the household survey to elicit consumption or income estimates, which are not only very time-consuming to collect but often imprecise when it comes to poor rural communities. As proposed in the literature (see e.g. Sahn and Stifel 2000, 2003; Filmer and Scott 2008; Howe et al. 2009) we therefore constructed an asset index from 30 assets to proxy for the relative household wealth of the participating individuals (see Annex 2 for the used assets and the applied methodology).

Table 3: Descriptive statistics for key variables (N = 122)

Variable	Mean	Std.Dev.	Min	Max
Age	44.8	16.86	22	99
Gender (1=Male, 0=Female)	0.64	0.48	0	1
Household size	5.85	2.96	1	15
Position in household				
- *Head*	73%			
- *Wife/husband*	21%			
- *Relative*	6%			
Years of schooling	2.94	4.09	1	15
Asset index (1=Highest, 0=Lowest)	0.19	0.14	0	1
Main activity				
- *Farmer*	66.84%			
- *Artisan/merchant*	11.76%			
- *Salaried employee*	5.88%			
- *Housewife*	4.20%			
- *Other*	11.32%			
Earning stability (1=Yes)	0.72	0.45	0	1
Access to savings (1=Yes)	0.74	0.44	0	1
Water shortage (1=Yes)	0.85	0.35	0	1
Religion				
- *Catholic*	44.70%			
- *Voodoo*	29.55%			
- *Christian*	13.64%			
- *Muslims*	6.82%			
- *Agnostic*	3.03%			
- *Jehova's witness*	1.52%			
- *Apostolic*	0.76%			
Faith/fate				
- *Strong influence*	79%			
- *Moderate influence*	16%			
- *Low influence*	4%			
- *No influence*	1%			

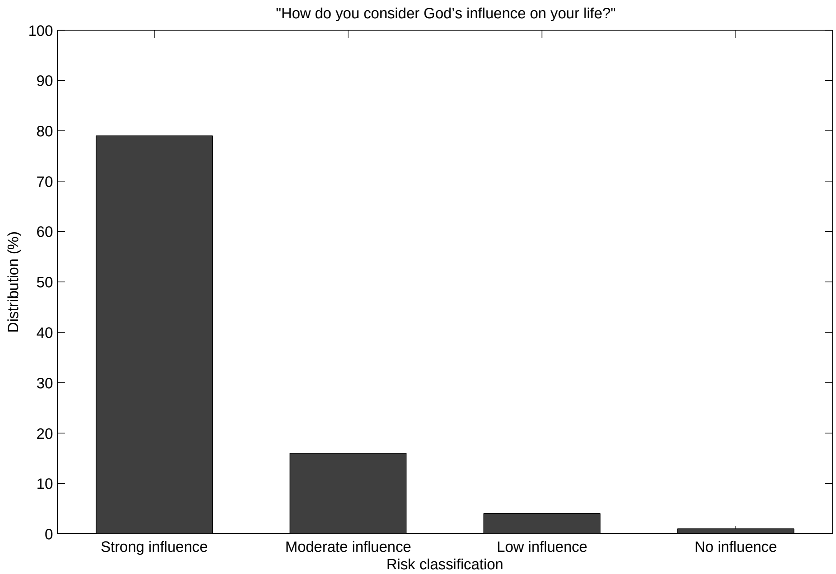
Source: Authors' compilation

To test for the potential effect of background risk on risk preferences we also include self-reported volatility of earnings (*earning stability*), access to a saving scheme, and experience of water shortages in our final econometric analysis. Earning volatility is high because incomes largely depend on (fluctuating) weather conditions and agricultural production. To hedge some of the unexpected or larger shocks, most households are aware of the role of savings and a large proportion of them (74 per cent) participate in personal or collective thrift schemes.[9] Being vital to individuals while inexpensive and without substitutes, the inability to pay for drinking water and hence to experience water shortages, is most likely to be the result of income shocks and not the result of preferred budget allocations.

Two important variables for our econometric analysis are the religion and faith/fate of individuals. Religion plays a significant role in Benin, with complex interactions between official churches and a strong 'voodoo' heritage (Benin is the historical cradle of voodoo). Within our sample, Catholicism is predominant with a share of 44 per cent, followed by voodoo (29.55 per cent), other Christian churches (13.64 per cent) and Islam (6.82 per cent). The influence of voodoo is in reality larger than its relative share, because most of the households maintain a cohabitation between their official religion and certain voodoo practices, either publicly or in private. Apart from religion we also try to understand the faith of the participants. We therefore asked to what extent God (or any representation of a higher spiritual being) is responsible for the outcomes in their daily life. Since the question is both conceptually difficult and potentially sensitive, the interviewers spent an appropriate amount of time with each participant to ensure that the question was perfectly understood. Despite being labelled as 'God' in the various tables and figures of this paper, the question was adjusted for each villager to account for religious differences (for instance Allah for Muslims).

[9]During our experiments, which took place during a period of high weather stress, it was clear that most of the schemes were not endowed enough to support more than one collective shock in the village. Most of the existing schemes were depleted at the time of the interviews.

Figure 1: Faith/Fate/God's perceived influence on personal life



Source: Authors' compilation

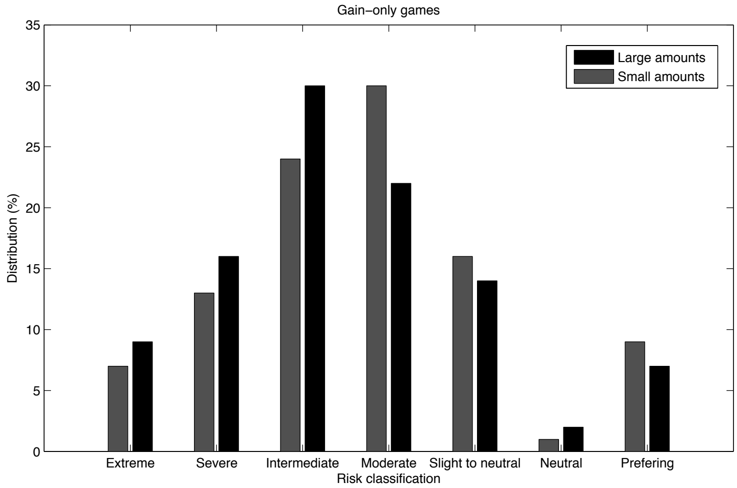
As shown in Figure 1, 78.7 per cent of individuals consider that they have almost no influence on their daily life and well-being as they fully rely on God's decisions, 16.4 per cent report a shared influence with God and 4.1 per cent a strong personal influence without much help from God. Less than 1 per cent consider that God has no influence at all on their lives. As an example, when asked about the strategies that the villagers deployed to limit the impacts of a dry August, a widespread response was *'to seed as usual and pray for God to bring the rain'*. What remains unclear and out of the scope of this paper is the causal relationship between this form of external fate and development opportunities: It could either be that faith in God's fortune hinders the search for opportunities or that the absence of opportunities (lack of capital, credit and insurances, overexposure to shocks) reinforces the coping mechanism of faith.

4 Descriptive results and econometric analysis

4.1 Descriptive results

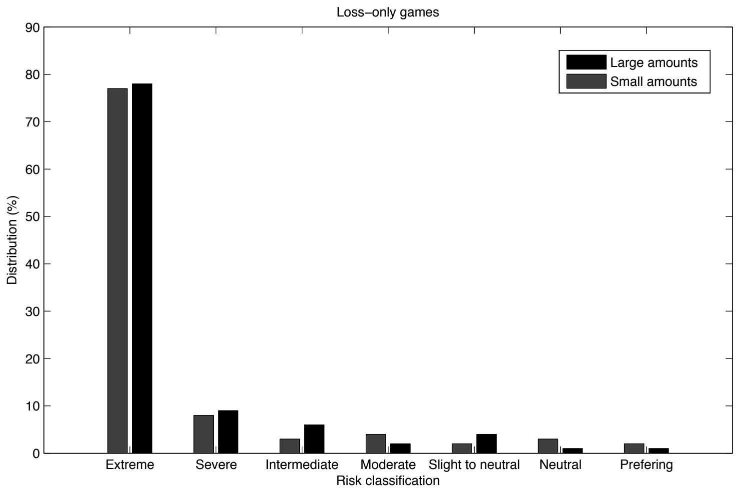
Figure 2 displays the general distribution of the CPRA parameter γ for the 'gain-only' games. The distribution of γ displays a shape similar to a Bell curve, centered around intermediate and moderate levels of risk aversion and with a unique mode. It is apparent that playing games with larger stakes shifts the distribution slightly towards more conservative risk taking. The shape of the distribution is similar to Wik et al. (2004) and is less skewed than Yesuf and Bluffstone (2009) towards highly risk averse categories.

Figure 2: Distribution of risk classes for gain-only games (small and large stakes)



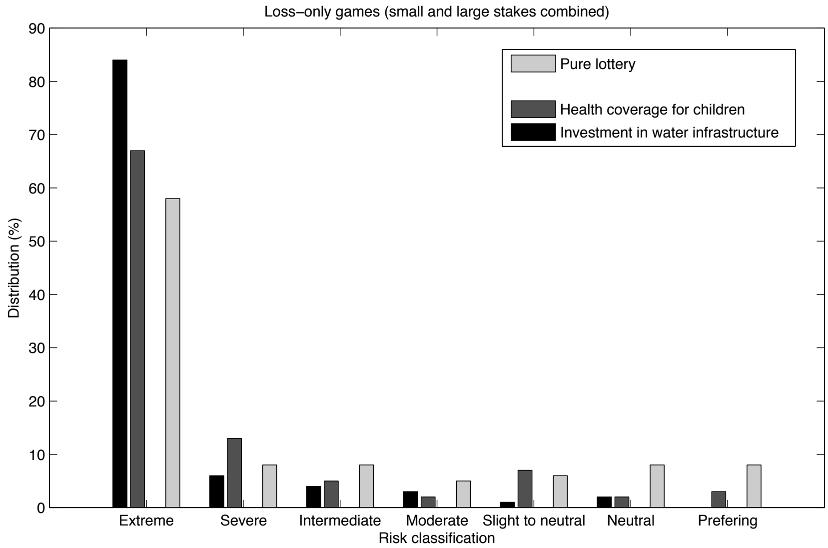
Source: Authors' compilation

Figure 3: Distribution of risk classes for loss-only games (small and large stakes)



Source: Authors' compilation

Figure 4: Distribution of risk classes for the different framing used in loss-only games



Source: Authors' compilation

For the case of the 'loss-only' sequence, most villagers were first reluctant to select between alternatives with only negative pay-offs. To make the decision easier for the participants we slightly framed the games as a choice between different levels of real-world protection. We used two framed scenarios: one on health coverage for children[10] and one on reparation costs for a specific asset.[11] The different scenarios were applied randomly across villages, which allows us to test for framing distortion when playing games in the loss domain. The results of our econometric analysis indicate, however, that there is no significant framing effect on the elicited risk aversion parameter. To test for a possible distinction between real life framing and simple lotteries (which are often associated with inconsequential decisions) we played an unframed scenario forcing a decision without justification with a third of the participants. In this setting, the players are informed that since they received an initial endowment, they have the obligation to choose an alternative even if both scenarios result in a loss.

Figure 3 gives the γ (CPRA coefficient) distribution for the 'loss-only' (small and large stakes)

[10]The participant is placed in a situation where one of the children has to be treated for malaria. Each proposed category for the sure loss represents a certain amount the participant will spend on medications, with the highest investment leading to the child being fully treated. But with lower medical expenditures, the risk of a relapse would trigger higher and additional costs.

[11]The participant has an important piece of equipment (which is selected in accordance with the player's assets) that is on the verge of failure. He can either pay for a partial reparation, hoping that it will suffice or he can decide to replace entirely the equipment, ensuring that in any circumstance, it will not fail in the future. To frame the story along the lines of our game, the participant can decide to have no reparation, or a increasingly costly reparation scheme that will decrease the amount of a second reparation in case of failure (but has no effect on the probability of failure).

games and Figure 4 shows the distribution of γ for the different framing scenarios, with limited distributional difference between the two 'realistic' scenarios. As expected, presenting the loss experiment as a lottery decreases risk aversion. It is also apparent that in losses, participants showed higher risk aversion than for risky gains. This result contradicts the assumed view of increased risk taking in losses that emerged from many experiments conducted in industrialized countries (Libby and Fishburn 1977; Fennema and Assen 1998; Harbaugh et al. 2002).

4.2 Econometric analysis

When setting up our econometric estimations, we have to account for the ordered nature of our risk classification (seven discrete categories from extreme risk aversion [1] to risk seeking [7]) and for the panel structure of our observations (the players are represented four times in our data structure, as they play four different games each). To account for those characteristics, we use an ordered probit model in which risk aversion is a latent variable of the following linear form:

$$y_{ij}^* = x_i\beta + u_{ij}$$

where y_{ij}^* is the latent risk aversion expressed by player i in game j, x_i is the vector of explanatory variables for the player i and u_{ij} is the residual error term. To account for the individual clustering in our observations, we model the error term as the sum of of an individual effect c_i and a idiosyncratic error ε_{ij},such that:

$$u_{ij} = c_i + \varepsilon_{ij}$$

Since y_{ij}^* is never observed, the observed variable y_{ij} is assumed as follows:

$$\begin{aligned}
y_{ij} = 1 &\quad \text{if} \quad \alpha_0 = -\infty \leq y_{ij}^* \leq \alpha_1 \\
y_{ij} = 2 &\quad \text{if} \quad \alpha_1 \leq y_{ij}^* \leq \alpha_2 \\
y_{ij} = 3 &\quad \text{if} \quad \alpha_2 \leq y_{ij}^* \leq \alpha_3 \\
y_{ij} = 4 &\quad \text{if} \quad \alpha_3 \leq y_{ij}^* \leq \alpha_4 \\
y_{ij} = 5 &\quad \text{if} \quad \alpha_4 \leq y_{ij}^* \leq \alpha_5 \\
y_{ij} = 6 &\quad \text{if} \quad \alpha_5 \leq y_{ij}^* \leq \alpha_6 \\
y_{ij} = 7 &\quad \text{if} \quad \alpha_6 \leq y_{ij}^* \leq \alpha_7 = +\infty
\end{aligned}$$

where α_i represents the upper and lower boundaries of the risk coefficient brackets (see Table 1 and 2). To limit selection bias when it comes to selecting the explanatory variables for the final econometric specification, we use a step-wise algorithm that selects sequentially variables among a large set of potential candidates (see Annex 1 for all variables included). At each step, the algorithm adds to the existing vector of explanatory variables x[12] the variable from the remaining set, which shows the lowest p-value among the tested variables. This forward

[12]Before the first run, the vector is empty as no variable is assumed to be relevant *a priori*.

selection process is motivated by its computational speed, several order of magnitude faster than the unconstrained algorithm that would have tested for all possible combinations of explanatory variables. While an unconstrained approach ensures that the selection is optimal, we remain confident that our approach yields reasonable results, results that match very closely the variables that we would have qualitatively selected based on previous theoretical and empirical literature and the experiment's context. Compared to similar literature, this approach is also an improvement since it does not rely on personal judgements and allows for an alternative list of variables that can then be compared with a qualitative selection based on economic theory.

The number of variables included in the estimation is bounded using a Likelihood-ratio (LR) test that compares the latest iteration (nesting model) to the model obtained one step before (nested model), such that:

$$LR = -2\{lnL(\hat{\theta}_r) - lnL(\tilde{\theta}_u)\} \overset{a}{\sim} \quad \chi^2(h) \quad \text{under } H_0$$

with $\hat{\theta}_r$ being the parameters of the restricted (nested) regression, $\hat{\theta}_u$ the parameters of the unrestricted (nesting) regression, h the number of restrictions imposed (equals to 1 in each loop) and H_0 represents the hypothesis to test that the two models are identical. When the test cannot reject at a specific level that the two latest iterations provide identical results, the algorithm is stopped. The selected variables are then used to first regress the full data set, then the subsets of gain-only and loss-only observations and finally the subsets of small stakes and large stakes. From the full set of variables (see Table 3 and Annex 1) the following variables were not selected as relevant by the algorithm: position within the household, household size, years of schooling, main activity, experience of water shortage, access to savings, religion and village dummies and are hence not included in the final specification (see Table 4 and 5).

Table 4 shows the estimation results for the full data set and the gain/loss subsets. Table 5 presents the results for the full data set and the small/large subsets. For each subset we further provide a second specification where we add a set of control variables - household size, village dummies and education levels - that were not preselected during the step-wise algorithm, but that are usually controlled for in similar work on risk aversion. In the end, none of these control variables turned out to be significant. Note that a negative coefficient indicates lower risk taking, e.g. higher risk aversion, whereas a positive coefficient indicates higher risk appetence.

One of the two main results of this study is that games constrained to the loss domain are highly negatively correlated with risk taking behaviour, a phenomenon intensified in games with large stakes (see Table 5). This result tends to confirm the existence of reference points when evaluating risks. However, the results of the large-scale socio-economic survey, that interviewed the same individuals, indicate that in real life villagers take high risks with regard to their personal health. We can either hypothesize that most of the villagers are indeed budget constrained and are forced to give up on basic insurance techniques, that participants have high discounting rates for the future which prevents them from investing in preventive health measures, or that they have internalized certain risks as facts of life, no longer considering some of the shocks as risks

Table 4: Ordered Probit regression on the full set, gain-only and loss-only subsets

DV: Risk appetence	A(full)	B(full+contr.)	C(gain)	D(gain+contr.)	E(loss)	F(loss+contr.)
	(1)	(2)	(3)	(4)	(5)	(6)
Strong faith influence	0.621	0.458	0.775	0.656	0.538	0.426
	(0.159)***	(0.180)**	(0.221)***	(0.256)**	(0.300)*	(0.289)
Loss games	-1.769	-1.836				
	(0.164)***	(0.189)***				
Previous luck	0.335	0.387	0.639	0.667	0.619	0.712
	(0.107)***	(0.108)***	(0.178)***	(0.195)***	(0.273)**	(0.284)**
Earning stability	0.291	0.153	0.359	0.158	0.231	0.311
	(0.134)**	(0.182)	(0.195)*	(0.248)	(0.235)	(0.321)
Large payout game	-0.161	-0.162	-0.496	-0.537	0.299	0.349
	(0.085)*	(0.088)*	(0.135)***	(0.154)***	(0.244)	(0.264)
Asset index	-0.831	-1.312	-0.856	-1.740	-0.987	-2.138
	(0.361)**	(0.438)***	(0.469)*	(0.669)***	(0.607)	(0.694)***
Age	-0.008	-0.008	-0.003	-0.004	-0.019	-0.019
	(0.004)**	(0.004)*	(0.005)	(0.006)	(0.006)***	(0.008)**
Gender: F	-0.419	-0.352	-0.187	-0.201	-0.884	-0.887
	(0.136)***	(0.136)***	(0.182)	(0.204)	(0.219)***	(0.228)***
Selfishness	-0.431	-0.586	-0.688	-1.012	-0.095	-0.206
	(0.230)*	(0.315)*	(0.259)***	(0.386)***	(0.340)	(0.486)
Obs.	476	460	238	230	238	230
e(r2-p)	0.177	0.199	0.058	0.143	0.075	0.139
χ^2 statistic	164.789	196.806	33.916	126.223	28.205	3048.264

Source: Authors' results

possible to hedge.[13] All of these topics are starting points for future research.

We partially test for path dependency by analyzing whether previous luck in tossing the coin has a significant effect on the villagers' risk preferences. To do so a dummy is constructed that takes the value 1 when the previous game ends with a win.[14] In all sample subsets, a previous win has a significant and positive impact on risk taking. This change of perception could either be caused by the increase in wealth obtained in the previous game (validation of a DARA hypothesis) or by a change in the perceived probabilities.

However, when the impact of a previous luck is jointly analyzed with the coefficient associated with the wealth levels of households, it seems that the DARA hypothesis cannot be validated: a larger wealth among villagers is actually negatively correlated with risk taking for all subsets, indicating increasing absolute risk aversion (IARA). Compared to similar experiments in developing countries, this result is puzzling since the DARA hypothesis is generally assumed and frequently observed in experiments (Binswanger 1980; Wik et al. 2004; Yesuf and Bluffstone 2009). Since richer participants are also the most educated ones (and maybe also the ones who

[13] Malaria is a good example of this form of 'determinism'. Despite being educated and trained on the subject, most of the interviewed villagers consider that episodes of high fevers are irrepressible parts of their lives that they have to live with.

[14] We do not consider anterior games when designing the dummy. This is to assume that an immediate win/loss has a stronger effect than previous wins/losses.

Table 5: Ordered Probit regression on the full set, small-only and large-only subsets

DV: Risk appetence	A(full)	B(full+contr.)	C(small)	D(small+contr.)	E(large)	F(large+contr.)
	(1)	(2)	(3)	(4)	(5)	(6)
Strong faith influence	0.621	0.458	0.607	0.540	0.628	0.393
	(0.159)***	(0.180)**	(0.195)***	(0.213)**	(0.185)***	(0.213)*
Loss games	-1.769	-1.836	-2.024	-2.241	-1.552	-1.621
	(0.164)***	(0.189)***	(0.283)***	(0.322)***	(0.222)***	(0.255)***
Previous luck	0.335	0.387	0.549	0.716	0.542	0.629
	(0.107)***	(0.108)***	(0.303)*	(0.323)**	(0.158)***	(0.169)***
Earning stability	0.291	0.153	0.247	0.141	0.312	0.166
	(0.134)**	(0.182)	(0.153)	(0.205)	(0.163)*	(0.214)
Large payout game	-0.161	-0.162				
	(0.085)*	(0.088)*				
Asset index	-0.831	-1.312	-0.574	-0.852	-1.076	-1.841
	(0.361)**	(0.438)***	(0.496)	(0.588)	(0.406)***	(0.542)***
Age	-0.008	-0.008	-0.008	-0.007	-0.008	-0.008
	(0.004)**	(0.004)*	(0.004)*	(0.005)	(0.004)*	(0.005)*
Gender: F	-0.419	-0.352	-0.499	-0.359	-0.351	-0.368
	(0.136)***	(0.136)***	(0.138)***	(0.161)**	(0.176)**	(0.174)**
Selfishness	-0.431	-0.586	-0.341	-0.657	-0.500	-0.528
	(0.230)*	(0.315)*	(0.365)	(0.487)	(0.264)*	(0.299)*
Obs.	476	460	238	230	238	230
e(r2-p)	0.177	0.199	0.17	0.203	0.193	0.229
χ^2 statistic	164.789	196.806	98.463	168.266	118.408	161.685

Source: Authors' results

understand better the implications of risk), we added the education level (number of years of schooling) to our list of explanatory variables to test for a potential education bias. However, the education level does not influence the significance nor the magnitude of the wealth's influence on risk aversion.

We can think of two explanations for this somewhat surprising result. First, all of the participants in our experiments are poor by international and even national standards. The less (but still) poor might hence care more about their investments than the very poor, who consider risky endeavors as the only way to get out of their current situation; in a manner similar to what is observed among casino players, who at the brink of losing everything, go for the most risky bet. This phenomenon would be close to the disposition effect (see Weber and Camerer 1998). A second potential explanation could be that the observed positive correlation between wealth and risk aversion is not the result of increasing absolute risk aversion (IARA) but the result of a reverse causality or a selection bias, where highly risk averse people tend to perform better in accumulating wealth. Further investigations of the causality between wealth and risk aversion will be carried out in future research. In line with the literature (e.g. Sillers 1980; Binswanger 1980), the regressions confirm that villagers display increasing partial risk aversion (IPRA), with a negative and significant coefficient for the dummy on large stake games, with the notable exception of the loss games for which the relationship is positive but insignificant.

Our second main result, is the very strong influence of the participants' perception of God's influence on their lives on risk aversion. *Faith* is a dummy that takes the value 1 if an individual announces that God has a strong influence on his life, and the value 0 otherwise. *Faith* has a highly significant and large positive impact on risk taking in any of the games played: for both the gain-only and loss-only games (Table 4) as well as for the small and large stake games (Table 5). The results indicate that faith has an important effect on decision-making in presence of uncertainty, a phenomenon also observed in Sjöberg and af Wahlberg (2002). The coefficient is positive which shows that villagers with higher reliance on their faith are also more susceptible to take on larger risks. It is also noteworthy that, apart from the 'loss-game dummy', this is the coefficient with the largest magnitude. Interestingly, the type of religion (Catholic, Muslim, Christian, other) does not seem to matter for decisions involving risks. Coefficient on religious dummies never turned out to be significant (irrespective of the specification chosen).

Turning to other collected information on participants apart from religion and faith, we found that background risk (measured as household's self-reported earnings volatility, where stable earnings take the value 1) has a positive and significant impact on risk taking. This indicates that individuals with fluctuating incomes tend to be more risk averse. This result is in line with the effects of natural disasters on risk perceptions observed in den Berg et al. (2009). Moreover, older participants are slightly more risk averse, but the effect is almost negligible. Women are also significantly more risk averse, a behaviour particularly noticeable in games of risky losses.

We further tested for a free-riding trait (i.e. *selfishness*) in individuals before playing the games. To do so, each person was asked hypothetically if he is willing to contribute to a public good knowing that the rest of the group already contributed (and that the contribution is anonymous). The dummy *selfishness* represents the villagers unwilling to contribute. The regression seems to indicate a negative correlation between 'selfishness' and risk taking. These individuals seem to be motivated by their personal gains and tend to believe more in their careful own decisions than taking high risks and hoping for 'God's good will' or participating in public goods and believing in community efforts.

5 Conclusion

Despite the widely known results of Kahneman and Tversky (1979) on risk perceptions in gains and losses and their implications on decision-making under uncertainty, it remains unknown how poor populations perceive uncertain losses. Such an understanding is, however, crucial to evaluate whether additional hedging schemes (such as micro-insurances) are the right mechanisms to improve the welfare of the poor in highly uncertain environments. Empirical evidence suggests that poor rural populations take unconsidered high amounts of negative risks in their daily lives. To test if these limited hedging behaviours are the results of pure risk preferences in losses, the consequence of some budget constraint, a high discount rate, a form of fatalism or a lack of insurance supply, we conducted several lottery-based games to elicit risk preferences in both gains and losses in a context devoid of time and budget arbitrages.

Our econometric results indicate a strong shift towards risk aversion when limiting the games to risky losses: a sign that villagers are predominantly risk averse when faced with potential losses and no budget constraint and/or time considerations. This result would indicate a demand for hedging schemes. It remains, however, to be seen if the payment of a minimal premium (a basic condition for ensuring a sustainable risk mitigating scheme) can compete with other expenses and does not reach budget limits. It is also unclear if villagers display the same risk preferences in situations presenting a time dimension. It could also be that they do not fully realize the nature of the risks involved in their daily lives as clearly as during the games. It is also more than likely that they suffer from some risk perception biases (i.e optimism bias) commonly found among Westerners (Kahneman and Lovallo 1993; Weinstein 2004). Last, it could be that their revealed risk aversion in the theoretical, out-of-context games is not a perfect predictor of their real-life behaviour. We currently conduct additional experiments in Benin that will try to assess the power of lottery experiments to accurately predict real-life decisions involving risks. We will test if inferred risk aversion from our loss games correlate with the purchase of 'hedging' goods.

We also found, in line with the literature, that the hypothesis of IPRA was valid among our sample, while we rejected the DARA hypothesis, which also calls for further research. Moreover, our results indicate some form of path dependency, where past experiences lead to perception errors. Last, we observed a strong influence of faith (but not religion or church) on risk aversion, with stronger faith increasing risk taking for both positive and negative stakes. While the results was expected on the basis of earlier research (Hilary and Hui 2009; Kumar et al. 2011), its magnitude indicates that any attempt to increase hedging mechanisms among poor rural populations has to target religious backgrounds as a key factor of success.

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6 Annex 1: Initial variables for the selection algorithm

Variable	Definition	Selected by the algorithm
Village	Dummy indicator for the village (12 villages in total)	NO
Age	Age of the participant	YES
Gender	Gender of the participant	YES
Position in household	Head, wife, child	NO
Household size	Number of household members	NO
Years of schooling	Number of years spent in school	NO
Asset index	Size of the assets owned; index normalized to 1 (highest category)	YES
Religion	Dummies for Catholic, Christian, Muslim, voodoo, other	NO
Faith	Influence of a higher spiritual being on daily activities	YES
Earning volatility	Perceived volatility of annual earnings	YES
Savings and insurance	Current or past ownership of an insurance scheme or a similar safety net scheme (individual or group savings)	NO
Water shortage	Occurrences of a water shortage in the past year	NO
Selfish	Dummy indicating that a respondent is NOT willing to put money *alone* in a group investment outcomes of which are shared	YES
Loss game	Indicates if the experiment is a 'loss-only' or a 'gain-only' game	YES
Large amounts	Indicates if the experiment is a large amount or a small amount game	YES
Previous luck	Indicates if the player has won in the preceding game	YES

Source: Authors' compilation

6.1 Annex 2: Computation of the asset index

The asset index A_i for the household i was computed as a ordered index of an equi-weighted portfolio of possibly owned assets j_i, such that:

$$A_i = \left(\frac{1}{max_i(\sum_{j_i=1}^{J} n_{j_i}) - min_i(\sum_{j_i=1}^{J} n_{j_i})} \right) \left(\sum_{j=1}^{J} n_{j_i} - min_i \left(\sum_{j_i=1}^{J} n_{j_i} \right) \right)$$

with n_{j_i} the number of items for the owned asset j_i. Each household is ranked within the sample on a $[0,1]$ scale.

The list of assets is displayed in the table below:

Assets		
Comm. & transport	Farming	Housing
car	horse/donkey	mattress
motocycle	pig	bed
bicycle	cattle	table
canoe	poultry	armchair
moto	sheep	fridge
landline	plow	stove
mobile phone	farming tools	fan
television	construction tools	jewellery
radio	size of land owned	sewing machine
audio system	mill	electric iron