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Measuring Risk Perceptions: Why and How

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ABSTRACT

Economists study data on choices that people make and from this deduce people's preferences and expectations. This identification process, as well as the predictions based on it, becomes flawed when multiple sets of preferences and expectations are consistent with the same data. One way forward would be to measure directly people's expectations on future states of the world. This paper discusses the theoretical merits and practical constraints of doing so. Data on risk perceptions seem particularly relevant for understanding savings and investment behaviour in the developing world, where risk is pervasive and often posited to have significant costs. Although the main aim of the paper is thinking through the 'whys' and the 'hows' of measuring risk perception, some interesting, but still unrepresentative findings from the field are presented. For example, we uncover a puzzle in that respondents seem to be engaged in farming activities that are stochastically dominated by other farming activities. Furthermore we find evidence that suggests that for high-profile activities, like owning a shop, the heuristic of availability makes people without experience in the activity bias their distributions to the right compared to people with experience.

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I. INTRODUCTION

1. Economists study choices that people make and from this infer preferences and expectations. For example, Manski (1993) looks at different possible preferences and expectations of youth to explain investments in higher education. He concludes that if these youth do not condition their expectations of returns to schooling on their own ability, then a researcher who assumes they do may mistakenly conclude from observed choices that youth are unconcerned with the returns to education. Manski (2004) convincingly shows how in many econometric applications a whole range of preferences and expectations could be consistent with observed data. In his paper he advocates that economists should abandon their aversion to measuring expectations, as the unattractive alternative is to make unsubstantiated assumptions. In an experimental study using a simple game, Nyarko and Schotter (2002) report that beliefs they elicit from respondents do a far better job of explaining choices than do three commonly used belief formation models.

2. In development economics, most seminal empirical work on risk is based on household survey data of actual realisations (e.g. income, consumption or anthropometric outcomes), combined with data on past events (e.g. weather or illness shocks). Examples are Townsend (1994) on consumption smoothing; Udry (1994) on the role of loans in risk-sharing; and Dercon and Krishnan (2000) on unequal sharing of the consequences of risk within the same household. None of these papers needed to measure expectations to come to their conclusions. However, once one tries to understand savings and investment behaviour, one needs a more complete understanding of the risk environment in which an agent operates. This means having data on past states of the world, as well as on the individual's perception of future states of the world.[3] Such data would seem particularly relevant for understanding savings and investment behaviour in the developing world, where risk is pervasive.

[3] We will use the terms 'risk perceptions' and 'expectations' interchangeably to indicate such views.

3. Let us illustrate this point with a concrete example. The removal of barriers to the expansion of lucrative income-generating activities remains one of the most promising avenues to combating poverty in developing countries. That is why a section of the development economics literature is devoted to understanding income-portfolio decisions of rural households. In particular, there is concern as to why large sections of the population in the developing world do not seem to be engaged in the most profitable activities that are available to them. The most commonly cited reasons for the seeming inefficiency of many rural households' activity portfolios are risk preferences and missing credit and insurance markets. Furthermore, it has repeatedly been emphasised that their effect on the poor is worse than on the non-poor. Rosenzweig and Binswanger (1993) find that when rainfall patterns become more erratic, average profits of rich households in the ICRISAT data are not affected, but the average profits of poor household will decline substantially due to the income smoothing strategies that they apply. Eswaran and Kotwal (1990) show that this can happen even if households have similar degrees of risk-aversion. In their model credit constrained households are willing to pay a higher price for reducing *ex-post* income variability than non-credit constraint households with the same degree of risk aversion. While Reardon e.a. (1992) find that households in Burkina Faso diversify their incomes sources to smooth risk, other studies point to the importance of other factors. Dercon and Krishnan (1996) find that income portfolio differences between households Ethiopia and Tanzania are better explained by differences in ability, location and access to credit, rather than attitudes towards risk. Conley and Udry (2004), Bandiera and Rasul (2004) and Van den Broeck (2004) emphasise the role of information networks in farmers' decision to adopt new technology. More examples can be found in Alderman and Paxson (1992), Morduch (1995) and Dercon (2002).

4. Pinpointing the precise impact of risk on activity choice and, ultimately, income and growth is obscured by the entanglement of, among other things, *ex-post* consumption smoothing strategies and *ex-ante* income smoothing strategies (Dercon and Krishnan, 1996; Morduch 1995). The behaviour of a household with considerable *ex-ante* income risk, compensated by some *ex-post* consumption smoothing mechanisms (for example through a

network of insurance partners), may, in as far as we can observe in the data, be very much like that of a household facing less *ex-ante* income risk, but having poorer *ex-post* consumption smoothing mechanisms. For policy makers it is obviously important to distinguish these two effects to determine the marginal benefit of interventions. While in the latter case the introduction of formal insurance or the support of informal insurance organisations may be key to the triggering growth, a similar intervention in the former case would only cause crowding out of private initiatives, and interventions on the production side could be more advisable.

5. There are few studies that are able to disentangle these effects convincingly. In order to single out the effect of risk on growth we would ideally want (i) to measure how the household perceives risk associated with actual and potential income-generating activities and (ii) to have sufficient variation of this measure across observations in a household survey to enable statistical analysis. This paper presents a data collection method that would allow this to be done. The basic idea behind the method is very simple: to ask the respondent directly how he or she perceives the risk associated with a particular activity.

6. Interestingly economists rarely ask respondents directly about their views or opinions, preferring instead to rely on secondary data sources or information on the history of the household. However, secondary data sources may not always be available, or may not correctly reflect the local circumstances. Even if they do, there is much scope to believe that farmers may not have the same perceptions as local researchers. For example, it would be possible that a farmer is more sceptical than local researchers about a newly introduced cash crop. To be sure, it is not a matter of who is right and who is wrong, but rather of whose views are relevant to explain observed choices. It is clear that to explain the behaviour of the farmer it are the farmer's views that matter. Historical information on an activity would also yield inaccurate results. Changes at individual level (e.g. changes in health status, in demographic characteristics, or in education level) and changes at environmental level (e.g. changes in access to markets, and access to services) may strongly influence how history gets translated into future perceptions. To give just one example, someone may have had stable

flows of revenues in the past, but may currently have a debilitating disease leaving him more prone to shocks now than he was before. Ultimately, to explain the farmer's behaviour without making too many heroic assumptions about how he learns from history or his environment, we need to ask the farmer himself how he perceives risk.

7. A paper closely related to this one is Smith e.a. (2001a) and Smith e.a. (2001b). They ask respondents to list different types of shocks that they expect to face in the future and then further request them to rank these shocks in terms of importance. They discuss techniques that can be applied to quantify these responses in terms of both incidence and severity. These scores can subsequently be used as a variable in statistical analysis.

8. Our risk perception module, in contrast, probes for the risk of engaging in particular activities. We ask groups of respondents to consider a particular activity and to describe realistic intervals of production (e.g. how big is the yield in a good harvest, in an average harvest and in a bad harvest). Participants are then asked to place stones or magnets reflecting the likelihood of attaining each of the outcomes. The approach depends crucially on the ability to get across the notion of probability, and different experiences on how this can be achieved are discussed below.

9. The main difference between our approach and that of Smith e.a. (2001) is that we start from an activity and try to draw its distribution across the different states of the world, while they start from a shock and trace its consequences. As Smith e.a. (2001b) acknowledges, shocks are often related or interlinked. For example, people in their sample considered lack of water and lack of food as two separate shocks, while they are both due to drought. Our technique sidesteps this problem by taking into account the effect of all shocks at once. The downside is that, in its current set-up, it cannot take account of the covariance across income sources, which would be important for an overall risk assessment.

10. This paper is only concerned with the questions of *why* and *how* to measure risk perceptions. We intentionally used the full pool of respondents to pilot and continuously

improve the instrument, rather than aim at getting sufficient observations with one instrument to perform analysis. As this is a relatively unexplored instrument, we feel that it is worth sharing our experiences from the field experiments early on so that others do not need to struggle up the same section of the learning curve, but rather are able to build on what we have found to work in practice. To indicate the potential of the instrument, we do present some preliminary, non-representative results obtained at the end of the field visit while testing the final version of the module.

11. The rest of the paper is structured as follows. Section 2 discusses why the risk perception module benefits from an approach mixing qualitative and quantitative data collection. Section 3 describes findings from research on eliciting probability distributions from respondents. It discusses the heuristics that respondents use and the possible biases this may lead to. These heuristics, as well as other risk perception modules documented in the literature, are used to develop a risk perception module in Section 4. This section also discusses some of the lessons learnt on how to implement the instrument on the field. The results of a field experiment in one village are presented in Section 5. Section 6 ventures further to compare the distributions of the various activities with each other and suggest what could be learnt from these data. Section 7 discusses the relevance of the suggested techniques for policy makers and researcher. Section 8 contains some concluding remarks.

II. INTEGRATING QUALITATIVE AND QUANTITATIVE RESEARCH

12. There are different degrees to which quantitative and qualitative research can be integrated. For our purposes, a useful way to classify them is triangulation, sequential mixing and simultaneous mixing. When both methods are applied independently and conclusions are, afterwards, put together, we speak of *triangulation* (e.g. Chambers, 2001). When qualitative work assists in formulating hypotheses to be tested during quantitative work; or when interesting quantitative observations and seeming anomalies are taken back to the field to get input from the respondents, this can be called *sequential mixing* (Ravallion, 2001). While triangulation and sequential mixing are advised, if not essential ingredients for sound economic research, labelling them as “integrated” may be stretching the term a little. Some

recent attempts have been made at taking the integration process one step further by what has become known as *simultaneous mixing*:

> *"... it entails expanding the traditional types of questions asked in existing sample survey data used for poverty measurement, drawing on the more subjective questions and participatory methods favoured in QUAL work, but imposing structure, such as rigorous sampling methods and pre-determined qualitative scales"* (Ravallion, 2001).

This type of integrated data is still relatively rare (some examples can be found Smith e.a., 2001a; Ravallion and Lokshin 2001; Ravallion and Pradhan, 2000).

13. This paper gives a concrete example of how one can simultaneously mix qualitative and quantitative methods. We discuss a risk-perception module that borrows heavily from qualitative research methodologies, but is designed to be integrated in multi-purpose household surveys. It aims at eliciting information on *ex-ante* risk households face. While researchers often collect information on shocks that have occurred in the past, data on perceptions of shocks that are expected to occur in the future are relatively scarce. In part this has to do with the economist's bias to what can be supposedly objectively measured and to discredit 'opinions' or 'views' of respondents. The paradox of this is pointed out nicely by Ravallion (2001):

> *"The main barriers to mixing QUAL and QUAN methods appear to lie in the resistance of practitioners and reviewers to stepping outside the traditional boundaries of practice. Economists have traditionally eschewed subjective questions; oddly, while economists generally think that people are the best judges of their own welfare, they resist asking people directly how they feel."*

14. We would argue that this is even more so for risk perceptions, as it is the *perceived* risk and not the actual risk that determines current behaviour. One may be inclined to think that past outcomes are the best available predictor of future outcomes. However, this is trying to second-guess the respondents' perceptions and would intuitively appear to be inferior to asking them directly. A farmer may use more than his own history to shape his views on the

future. He may complement it by what he sees around him, what he hears from others in the village or what politicians promise him. Furthermore, there may be changes in his environment that give him a different perspective on things. For example a farmer may have been prone to shocks in the past because he faced labour constraints. He may, however, have recently married and have solved this problem. A village may have had shocks related to erratic marketing of a perishable crop in the past, but may not perceive this a future threat if a road rehabilitation project has recently been concluded.

15. In any case, the economist's practice is at odds with one of its own favoured paradigms for expectations modelling, rational expectations, whereby all information available to the researcher has to be taken into account, beyond past events. The backward-looking adaptive expectations modelling became strongly criticised in the 'Lucas Critique' of economic policy making (Lucas, 1976).

III. FEASIBILITY OF MEASURING RISK PERCEPTIONS

16. Respondents will typically not hold fully formed probability distributions in their heads. Hence the researcher will need to elicit these distributions from the respondent in some way. Morgan and Henrion (1990) give an extensive overview of the problems involved in this. They discuss at length the work of Kahneman e.a. (1982), which uncovers some of the heuristics that people are likely to use when requested to report probabilities. First, there is the *heuristic of availability*, which implies that a person's probability judgement is driven by the availability of previous occurrences of the event, or by the ease with which the occurrence of the event can be imagined. They argue that for events for which the respondent does not have personal experience, this availability can be different between certain types of events, even if the events have equal chances of occurring in reality. One reason for this may be because the media pays differential attention to the events. Indeed, Dominitz and Manski (1997) find that respondents overestimate the probability of burglary; Black e.a. (1995) find that women overestimate the likelihood of breast cancer; Viscussi (1992) reports that people overestimate the probability of lung cancer for smokers.

17. Secondly there is the *heuristic of representativeness*, which implies that the respondents believe that the structure of the event contains information on its representativeness. For example, people will judge the string of coin tosses HTHTTH to be more likely than HHHTTT, while in fact it is equally likely.

18. Thirdly there is the *heuristic of anchoring*. Applying this heuristic makes respondents sensitive to any value that is suggested to them during the exercise. One striking finding in this line of research is that numbers seemingly unrelated to the probability distribution at hand will influence the response. For example Kahneman and Tversky (1973) conducted an experiment in which they first spun a wheel of fortune in the presence of the respondents and then asked them to estimate an unrelated quantity, like the proportion of African countries in the UN. The respondents were led to believe that wheel yielded a random number between 1 and 100, while in fact it could only fall on either the number 10 or the number 65. The respondents who in the first step of the experiment saw the wheel indicating the number 10 estimated the proportion of African countries in the UN to be significantly lower than the respondents who saw the wheel falling on 65.

19. Bruine de Bruin and Fischhoff (2000) find that when people are asked to associate a probability to a binary event they may use 50% to indicate what they term epistemic uncertainty, namely that the respondent has no idea what the probability is. They note a 50-blip in many data on risk perceptions and conclude this is largely due to respondents confusing the phrase “fifty-fifty” – meaning I have no idea – with the number 50, meaning there is one chance in two. They suggest that presenting the respondent with a probability scale containing a full set of numerical responses may reduce this problem. Their findings are important in a second way. If we want to elicit distributions from respondents, then what do we do with respondents who display epistemic uncertainty? Ellsberg (1961) introduces the notion of ambiguity, which leads to the idea that respondents may hold several *sets* of different beliefs on the same event. Manski (2004) suggests, in the context of eliciting beliefs on a binary event, that the way to get round this problem is to ask respondents for a range of beliefs. For example, one may allow a respondent to say that an event will occur

with a probability between 20 and 80 percent. Epistemic uncertainty would then be articulated as a respondent reporting that the likelihood lies between 0 and 100 percent. Note that this is different from a person who reports that an event is likely to occur with 50% chance.

IV. DEVELOPING A RISK PERCEPTION MODULE

20. In this section we develop a risk perception module designed to elicit probability distributions of future output in particular activities. We first let the respondent form upper and lower boundaries of the distribution and subsequently derive a number of intervals for which the respondent will be requested to provide a probability of occurring. The module was devised over a long period of time with much trial and error in the villages in the study area. What is discussed below is the derived product after many fundamental changes, as well as important fine-tuning.

21. By instructing the interviewer to refuse to suggest any bounds to the respondent, we avoid biasing the respondent's responses through the heuristic of anchoring. By concentrating on common activities we avoid, to the extent possible biases related to the heuristic of availability. We experimented too with eliciting views on distributions of less common activities, like running a shop or farming a recently introduced cash crop. We notice here widely diverging views between people with and without personal experience, most likely related to the heuristic of availability. Note that the heuristic of availability is a bias only in the sense that it biases the respondent's view away from the true distribution. But in as far as respondents actually hold these views and act upon them; this heuristic could be an explanation of what we see, rather than a critique on how we measure.

22. The risk perception module is related to other modules available in the literature, especially Manski (2004) and Hardaker e.a. (1997). Manski (2004) uses a cumulative approach, whereby the respondent is asked to state the likelihood that the variable will be lower than a certain number. Hardaker e.a. (1997) asks respondents to assess the likelihood

of the value falling inside a certain interval. Our approach follows most closely that of Hardaker e.a. (1997).

23. The first step of the module is to decide which activities will be discussed. These can include any activities, even those in which households do not engage (e.g. a new crop, which they have heard about, but not yet planted). Then for each activity a facilitator goes through the following steps with the respondents:

- Discuss what the typical problems are when engaging in this activity, what are the effects on output and how likely are they to occur simultaneously? Which circumstances are good for this activity and how frequently are they likely to occur. At this point, the aim is to set the participants' minds to thinking about the activity and the risks and certainties involved.
- Ask the respondents in which units they prefer to measure output.
- Discuss what a normal output range would be; how much would output be in a very bad period and how much would it be in a very good period.
- From this range construct 4 or 5 intervals and write them down on a large sheet of paper or on a magnetic white board.
- Ask the respondent to place ten magnets on the board (or stones on paper), each magnet presenting the relative probability to attain an output in that interval.
- Let the respondents discuss among themselves whether there are any changes that need to be made.
- Once they have come to a conclusion, explain in words what the plotted distribution implies. If there are any doubts, probe further and make changes. Make sure all respondents agree with this interpretation.
- All relevant activity-specific shocks, units of measurement and the final distribution are noted. It may also be interesting to note intermediary distributions.

24. A pivotal step in this process is to bring across the concept of probability. This involves having the assistance of very professional facilitators. We tried two ways of explaining:

- There are now 10 people, all completely identical to the farmer under consideration. How many will end up in each interval?
- The farmer farms for 10 years (or whatever time unit the participants chose). How many years will he attain outcomes in each interval?

25. We found it easiest to explain the concept of probability by using method 1, preferably using a visual representation by drawing 10 farmers on the whiteboard. Once respondents had grasped the concept we could later on simply refer to probability in percentage terms. Method 2 worked less well and had the added danger that respondents may be lead to think in terms of learning and improving skills in an activity over several years.[4] In early stages we were more careful about introducing the concept of probability and had the respondents make some exercises first. One of these exercises was to let them consider past harvests and place the magnets on the whiteboard according to the past distribution. This was found to be unnecessary, as respondents could easily grasp the concept once the facilitator learnt the right phrasing in the local vernacular.

26. There are at least two moments where the facilitator can assess whether the respondents have grasped the essence of the game. The first is when the respondents discuss amongst each other how to allocate the magnets. The second is by asking one of the participants to interpret the results on the board. We usually asked at the end: "if a stranger walked into the room and saw what you had put on the board, how would you explain this graph to him".

27. During the field work we only attempted to apply the method at village level. Although village level data collection is advantageous from a budgetary point of view, there is an important additional problems that it creates: some important exogenous variables need

[4] When asking expectations on prices (exogenous to the farmer) an approach using 10 years may be suitable.

to be fixed to make sure that people are talking about the same type of farmer. For example in an area where labour and land constraints are important one would want to fix the amount of the farmer's land and decide how big is his household is. If there is evidence that yield distributions are influenced by fertiliser or other inputs (e.g. Babcock and Hennessy, 1996) then these need to be kept constant. We tackled all these problems at the beginning of the exercise by asking respondents to picture a typical farmer, and give his characteristics. The farmer was drawn on a white board, given a name, a plot of land, a family etc... To avoid having to fix the characteristics of the farmer it may be preferable to administer the module to individuals rather than to groups. The implications of doing this are discussed further in Section 8.

28. In order to compare and plot distributions of different crops against each other, all yields need to be valued in monetary terms. This exercise would preferably be conducted in a participatory fashion at the end of the session with the respondents. Additionally one has to be sure that the time intervals match in the sense that no particular harvest period has been reported. For example, if cassava production is reported yearly, but beans production is reported for the main bean season, but not for a smaller bean season at a different time of the year, then this will hamper comparability. Information on the costs involved in investing in the activity should also be collected.

V. RESULTS

29. The final version of the risk perception module was conducted in Kabirizi, a village at about 65 kilometres from Bukoba Town, the capital of the Kagera Region in Tanzania. The main crops are bananas and coffee, supplemented with cassava, maize, beans and sweet potatoes, etc. The area is dryer than most other areas of Kagera and has suffered in recent years from banana pests and diseases, cassava mosaic disease and highly volatile coffee prices. Attempts are being made to introduce vanilla as an alternative cash crop. Kabirizi has a small centre with 3 small shops. It is close to neighbouring Rubale and Izimbya, which are slightly larger centres.

30. In total we collected risk perceptions of 9 activities: cultivation of bananas, cassava, maize, beans vanilla and sweet potatoes; running a shop in Rubale and selling food on the weekly market. Finally we probed for people's perception of the future coffee price. Each activity was discussed independently in 2 groups. In total 6 groups, each consisting of three participants was invited to attend meetings. Each meeting lasted about 1 hour and discussed risk distributions for 3 activities. The parameters by which the exercise would be conducted were set out by the first group. They decided on the acreage and the units of yield and time that would be used. Other groups were tied to these in order to ensure comparability. No attempt was made to stratify the groups according to socio-economic characteristics; neither did we try to get risk perceptions at individual level.

31. Figures 1-9 below plot the results for each activity. Every graph has two lines, one for each group in which that particular activity was probed for. Each activity has 4 or 5 categories represented on the *x*-axis. The *y*-axis represents the percentage of magnets that group placed in the category. These points completely define the distribution for each category. However, lines have been drawn connecting consecutive points to obtain what statisticians sometimes refer to as a frequency polygon.

32. Figure 1 and Figure 4 give results for bananas and beans respectively. For bananas respondents chose to talk in terms of bunches of bananas per month grown on a plot of one acre. For beans they chose to talk in terms of tins (*madebe* in Swahili) of beans harvested in a year (aggregating 2 harvests). The graph has the same pattern, giving high probability weights to relatively low yields and low probability weights to relatively high yields. Note how the two independent groups gave very similar distributions (identical in the case of beans).

33. Cassava and sweet potatoes, plotted on Figure 2 and Figure 5, give a different picture. Here low yields have low probabilities, while high yields are perceived to be more likely. Note also the unusual way in which the participants advised us to talk about cassava yields: in terms of the number of sufficiently sized pieces of cassava per tree. In bad years,

especially when the cassava mosaic disease is severe, the number of pieces can go down to 0 or 1. In good years it can be as much as 6 per tree. Again independent groups came up with the same patterns for both crops.

34. Figure 3 shows the risk perception of maize. Here groups seemed to differ more than with the previously discussed crops, although there does seem to be a tendency to give low probability weight to high yields and high probability weights to average yields.

35. In a slightly different exercise we asked respondents about their expectations of the price of coffee. Coffee prices have been very volatile in the Kagera Region, with prices being as high as TSh 550 for a kilogram of unhulled coffee in 1995 and as low as TSh 40 in 2000. Figure 6 shows that, contrary to popular belief, respondents have not lost faith in coffee prices. Participants did not expect coffee to drop further to the level of 2002, but neither did they think it likely that it would climb up to its 1995 level. Coffee prices were perceived to be nearly normally distributed. Interestingly the expected mean lies slightly *above* the coffee price that had been announced in the village just a few weeks before our exercise. Again, note how small the disparity is between the two groups.

36. Figures 1-6 depict some of the most common crops of Kabirizi and all participants had a life time of experience with them. Once the characteristics of the hypothetical typical farmer were set, participants had very similar views on the probability distribution of his yields. All groups independently came up with very similarly shaped distributions. This is suggestive of the fact that respondents use the heuristic of availability to draw these distributions. By contrast Figures 7-9, concern activities in which only few people engage in. Most respondents do not grow vanilla, nor do they own shops or engage in catering at the weekly market. Still they frequently hear about and deal with people who do. A striking pattern that emerges from these preliminary and admittedly unrepresentative data is that people with experience in the activity have very different views from those that don't. In other words, even though participants were talking about the same hypothetical typical farmer, they had very different views on the profitability of the activity.

Figure 1: Risk Perception of Bananas

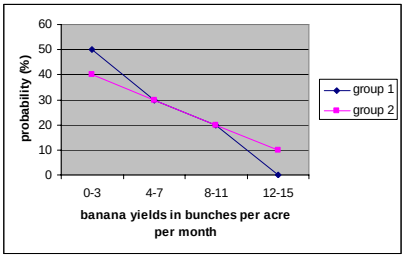


Figure 2: Risk Perception of Cassava

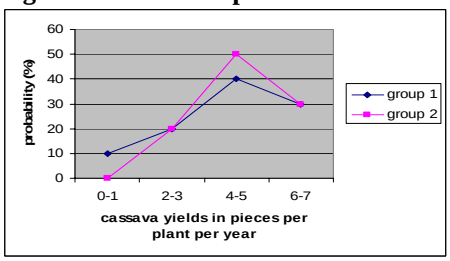


Figure 3: Risk Perception of Maize

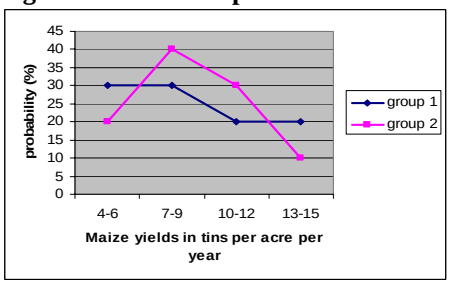


Figure 4: Risk Perception of Beans

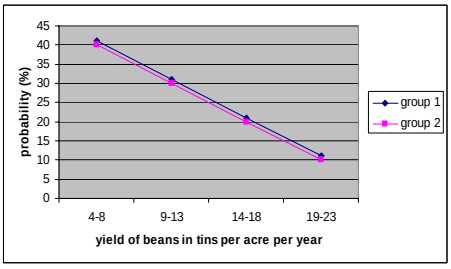


Figure 5: Risk Perception of Sweet Potatoes

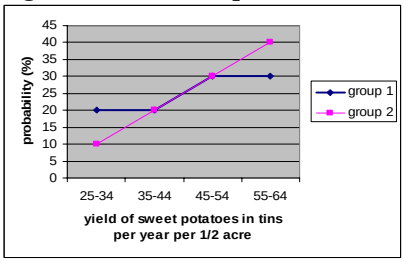


Figure 6: Risk Perception of Coffee Price

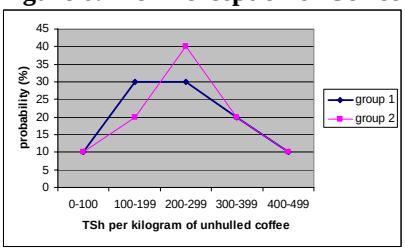


Figure 7: Risk Perception of Vanilla

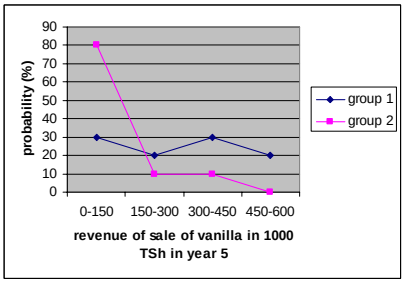


Figure 8: Risk Perception of Opening a Shop

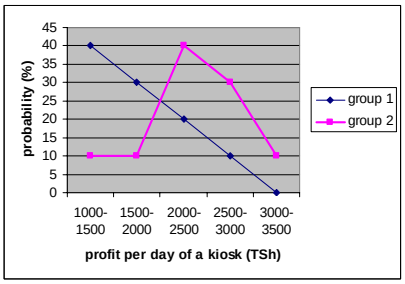
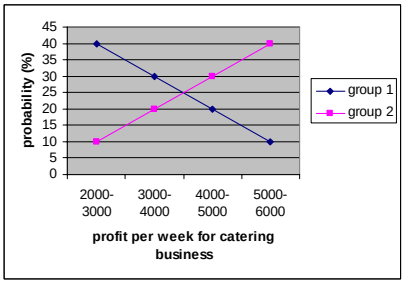


Figure 9: Risk Perception of Catering



37. Unlike other parts of Bukoba Rural, Kabirizi is not ideal for growing vanilla. The environment is very dry during a large part of the year and according to our participants a vanilla grower needs to incur very large costs to irrigate his plants. The participants of group 1 preferred to talk in terms of revenue (before costs) attained by 10 vanilla plants in the harvest of year 5. It was assumed that up to that year, about TSh 300,000 had been invested in the plants, which would be sufficient to ensure daily watering during the dry season.

38. Group 1 consisted of 1 vanilla grower. He had just started planting vanilla and was in year 2 of an investment that he expected to take him 3 years to get the first profits and 5 to 7 years before the plants get to full production. It is fair to say that, despite our attempts to get the others in the group involved, the vanilla grower dominated the group discussion as his knowledge on the subject was intimidating to the others. In that sense the distribution of group 1 in Figure 7 can be seen as that of a vanilla grower. The distribution is close to uniform across the possible range of values. Group 2 consisted of no vanilla growers and their perception of the yield of vanilla was very different from that of the vanilla grower. They thought that with 80% probability a vanilla grower would get close to nothing and with 20% probability he would get a small profit. Thus for vanilla it seems that the main reason for deciding to grow the vanilla was the perceived risk, which varied enormously between respondents. The outcomes of the few vanilla growers in the area (the believers) are likely to be key to shaping the perceived risk distributions of others (currently non-believers). This would be important to keep in mind for any extension work trying to promote this new cash crop.

39. Figure 8 and 9 tell an interesting story concerning small scale businesses. In both cases group 1 consisted of 3 people with business experience. One had sold second hand clothes; one had owned a small stall and one had previously operated a business of selling food on the weekly market. The first group set the parameters. In a first exercise an investment of TSh 200,000 was considered for opening a small shop in Rubale Centre, a small commercial centre a few kilometres from Kabirizi. They advised possible

outcomes to be measured in TSh of profit (revenue minus costs) per day. Figure 8 shows that, for the same exogenous characteristics of the investor, the experienced group gave higher probabilities to the lower outcomes, while those without business experience were a lot more positive about the investment. This response is easily explained if we believe respondents use the heuristic of availability: people with shops are considered rich and their alleged wealth may well be exaggerated in everyday conversation and gossip.

40. The outcomes for catering at the weekly market were even more pronounced. For the same investor, the experienced group had exactly the opposite distribution of the non-experienced group. The experienced group thought lower outcomes to be much more likely, while the inexperienced group considered high outcomes to be very likely. Again this may well be likely to the fact that success stories get more attention than failures and people exaggerate their occurrences by applying the heuristic of availability.

VI. COMPARING DISTRIBUTIONS

41. By making further assumption about prices and other parameters, we can convert yields into monetary value and plot activities on the same graph. Table 1 summarises the assumption we needed to make in order to do this.

Table 1: Assumption made to monetise reported production

crop	**unit used to measure yields**	**further assumptions made to convert to value in TSh per year**
bananas	bunches per month per year	Prices vary between TSh 1200 and TSh 1500 per bunch. We took an average of TSh 1350

cassava	pieces per tree per year	Plants are planted at 2 yards distance so that there are 35 rows of 35 plants = 1225 plants. Each piece of cassava can be sold at around TSh 70
maize	tins per year	Highly seasonal prices varying between TSh 2000 immediately after the harvest and TSh 5000 for those prepared to wait for several months. The majority of the farmers will sell at around TSh 2500 with traders speculating on the further price rises.
beans	tins per year	TSh 4000 per tin.
sweet potatoes	tins per year	The only crop out of this list which is difficult to market. Taking this into account, its price is estimated at TSh 500 per tin.
coffee	TSh per kilogram	We assume that an acre of land will yield 4 bags of coffee, with each bag of coffee containing about 58 kilograms. This implies that the total amount of coffee harvested will be about 232 kilograms/acre. Note that if variation in coffee production were taken into account the standard error of the distribution would increase.

42. Figure 10 plots the 3 most important crops in the traditional Haya farming system. Each figure consists of two graphs. The left graph plots the frequency polygon. Note that this has the same shape as the previously presented graphs. The only difference is that they are now comparable through the common, monetised *x*-axis. The right graph plots the cumulative frequency polygon. Beans emerge as a low-risk low-value crop, with its cumulative distribution being a near vertical line. Coffee follows with a near normal distribution: there is low probability of getting either very low or very high yields.[5] The value of the banana harvest has a wider range of probable values. Its logarithmic shape makes low yields highly likely but very high yields are possible.

[5] We only consider variation in coffee prices, including variation in yields may alter these results.

43. Figure 11 compares coffee and bananas with cassava. Even though the assumptions concerning the number of cassava plants per acre and the price of a piece of cassava were on the conservative side, a quick glance at Figure 11 would make cassava seem like a very profitable crop. At just over TSh 100,000 the cumulative probability distribution for coffee has reached its maximum, while that of cassava has just reached around 10%. This means that with 90% a certainty a farmer would earn more with cassava than he could make at maximum with coffee.

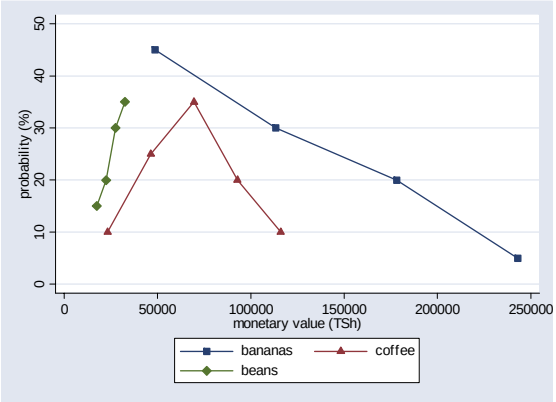
44. So why coffee and bananas do remains the main crops in the Haya farming system, while respondents claim cassava is more profitable? Although it is beyond the scope of this survey to provide a full answer, there are some possible explanations.

- ***Social Position***. Most anthropological literature on the Haya stresses the Haya aversion any other staple food apart from bananas (Reining, 1967 and Weiss 1994). It also stresses the social importance of bananas and having a well-maintained *kibanja* – the main field for all Haya consisting of intercropped banana, coffee and beans. A field of cassava may produce more income for the same cost, but would not produce the same social position. Except for direct enjoyment this creates, such a social position could also positively feed back into the economic situation of the household. For example, it would be difficult to be a local leader without having a respectable *kibanja*.
- ***Intercropping.*** Because bananas, beans and coffee are intercropped we may in fact have to sum up their yields to compare them to cassava (horizontal sum of the 3 graphs).
- ***Risk of Complete Harvest Failure.*** We did not collect detailed information on the bottom end of the distribution. A recent cassava mosaic disease has ruined cassava yields for many people. While banana weevils and other pests have affected bananas, it was not to this extent. A more accurate measurement of the likelihood of complete harvest failure may be important to explain behaviour.

- ***Production Costs and Credit Constraints.*** We only looked at yields and did not take into account the cost side. A field of cassava needs more intensive attention and involves costly labour inputs compared to bananas and coffee. This may be surprising to many readers, who consider cassava as the drought crop that will grow at any time, in any place, and with a minimum of labour. But in this area some farmers grow cassava for cash. In this case he will have a dedicated cassava field. He will typically plant everything at once, harvest everything at once and sell in bulk (or store to wait for higher prices).

45. Figure 12 depicts some of the low-risk, low-value options open to farmers in Kabirizi. The comparison between beans and sweet potatoes is interesting. Note that the cumulative frequency polygon for beans ends at a value below which the cumulative frequency polygon for sweet potatoes starts. Thus the graph of sweet potatoes dominates that of beans in the following sense: farmers perceive it as 100% certain that the value of a beans harvest will be lower than that of even the lowest sweet potatoes harvest. The fact that beans are not altogether replaced by sweet potatoes could be due to the fact that these two crops do not compete against each other in the factor market, as they have labour peaks in different periods and are grown on different types of plots. Furthermore, diversification by investing in both crops may make sense from a risk management point of view if their income streams are not expected to show much correlation.

Figure 10: The Traditional Haya Farming System: Coffee, Bananas and Beans



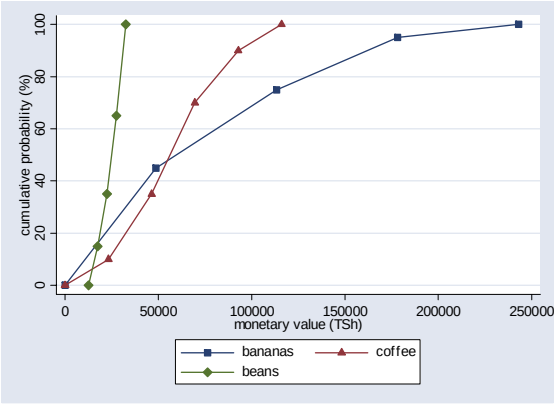
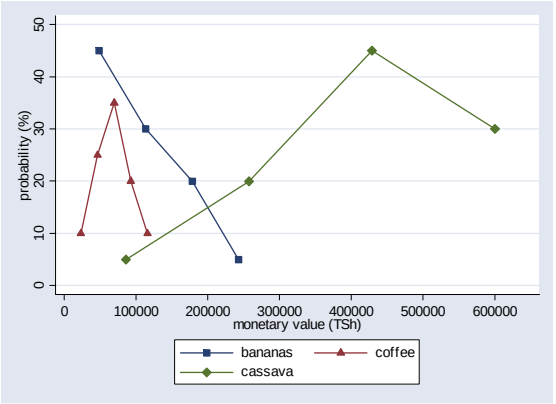


Figure 11: Bananas and Coffee vs. Cassava



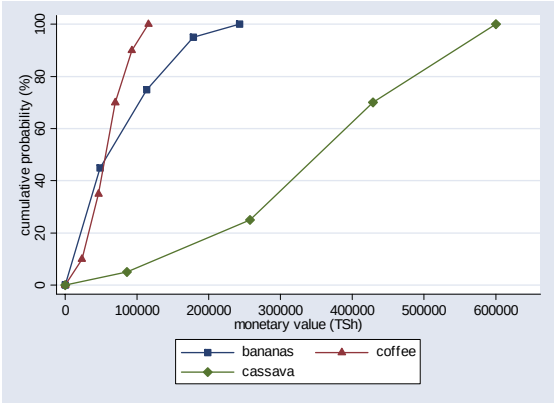
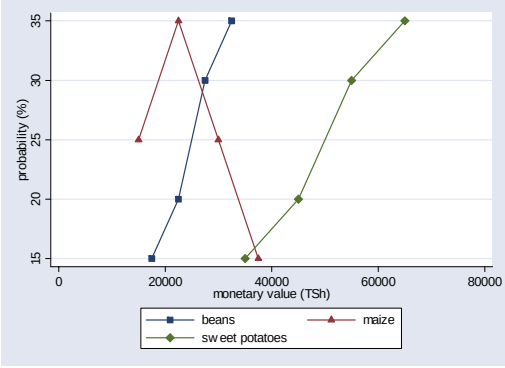
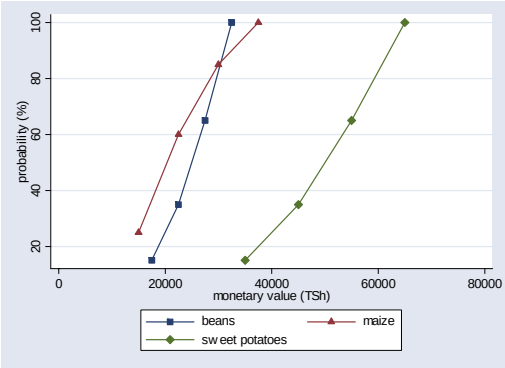


Figure 12: Low-yield, low-risk crops: maize, beans and sweet potatoes





VII. RELEVANCE

46. The most straightforward use of the risk perception module would be to characterise income generating activities in terms of how farmers perceive their risk distribution. This is a very valuable exercise and it should be noted that it has, to our knowledge, never been conducted before in Kagera; at least not a characterisation that would come directly from the farmers, rather than from research stations or historical macro production figures. This is important as it is the respondent's own views that shape his behaviour. It may be interesting to compare objective yield distribution (collected at, say, a local farmer extension centre) and compare it to what farmers perceive. It would not be surprising that discrepancies between their perceptions lie at the basis of failure of households to invest in new technology and the failure of researchers to account for it. This could provide important information for the design of programs introducing new technology.

47. This very small and unrepresentative study yielded some surprising results in that respect. First, it was not expected that people had such a positive outlook on coffee prices. At the time the module was administered, the popular believe was that in Kagera farmers had given up on coffee. Second, cassava in the Kagera region is usually assumed to be a low-risk, low-yield crop and most researchers and policy makers would take this as a given fact. The results of our exercise, although premature and not representative of a larger population suggest it is a low-risk, high-yield crop. If found true in a larger population, these simple observations could be of great value for the design of agricultural programs.

48. Assessing the consistency of these data with farmers' choices and looking for explanations for the inconsistencies could lead to innovative insights. For example if the distribution of one crop clearly dominates that of another one – in the sense that the cumulative distribution of the one starts where the cumulative distribution of the other ends – but we find that it is not cultivated by many farmers, and then we should try to find out what causes this. For example, if the results of this study were to hold true for the larger population then it would remain somewhat of a puzzle why people do not grow

more cassava, as it dominates the distribution of most other crops. The same holds for sweet potatoes and beans.

49. But the analysis can be taken further. Data on risk perceptions could help isolate the specific effect of risk on people's choice to be engaged in an activity, to stop an activity or to enter into a new one. For example, it is frequently hypothesised that households employ costly *ex-ante* coping mechanisms to reduce risk. One of these mechanisms is to engage in low-risk, low-yield activities, effectively placing the household in a vicious circle of poverty. There are relatively few papers who address this question empirically (see Alderman and Paxson, 1992; Morduch 1995 and Dercon, 2004 for overviews). To some extent the lack of empirical evidence may be due to data constraints. Ideally one would want to observe two identical households, where one is exposed to risk and another one is not. This is exactly the data that the risk perception module can provide, if used in combination with regression analysis on household survey data.

50. Say that such a research study finds that better-off farmers engage in high-yield, high-risk activities, while poor households cultivate low-risk, low-yield crops. It is then very difficult to assess whether the better-off households are able to bear the risk *ex-post*, or because they are able to make sufficient investment to avoid the risk *ex-ante* (e.g. access to inputs, access to labour at key moments). While previous studies usually needed to keep this question open, it could be straightforwardly answered from the data generated by the risk-perception module through comparison of distributions across both categories. Note that for this to be possible the module would need to have been conducted at individual level or in groups stratified on the basis of wealth. Disentangling *ex-post* and *ex-ante* smoothing strategies could help inform policy makers on the marginal benefits of interventions on the production side (e.g. irrigation) versus interventions on the consumption side (e.g. insurance). Furthermore it can help advise on differential policies that are needed for different sections of the population (targeting).

51. Preliminary data on investment in off-farm business presented in this report suggest that the heuristic of availability plays a crucial role in forming farmers' perceptions. Interestingly we found that this heuristic shifted the distribution to the right for inexperienced people. Participants without experience were significantly more optimistic about the potential profits to be made by running a shop than those that had actually performed this activity. Further investigation on the use of this heuristic could lead to valuable insights in how people learn-by-observing.

52. In the case of vanilla, a new cash crop in the region, the data suggested that the population is split into believers and non-believers. No one in the village had ever harvested vanilla and views on its potential were hugely varying. The experiences of those that have planted the crop are likely to be the main determinants of how views on this crop are shaped in the future.

VIII. CONCLUDING REMARKS

53. This paper aimed to show that collecting perceptions on *ex-ante* risk is possible and relevant. An unresolved issue is whether this exercise should be done in groups or with individuals. The risk perception module conducted in Kabirizi was conducted in groups of 3 respondents. This means that many household characteristics needed to be set and kept constant. The guideline we used was 'keep the hypothetical farmer under consideration as typical as possible'. This still poses the problem afterwards that we do not know whether the distribution holds for all farmers, or only for the ones that have the described characteristics. Essentially what we are collecting are common perceptions on risk, purged of idiosyncratic components and this needs to be kept in mind during the analysis.

54. From a theoretical point of view getting individual level risk perceptions would be ideal. First, it would increase the variation necessary for statistical analysis and second it would capture the heterogeneity of risk perceptions across households. The downside is that it would require much more resources and may increase measurement error. To begin

with, consider that it takes 10-15 minutes to explain the exercise and another 15 minutes per activity that has to be plotted. To get perceptions on about 3 activities this would easily add about an hour to an interview, something most household surveys would find difficult to manage. Collecting common perceptions is considerably faster and cheaper and will allow collecting information on a wider range of activities. Additionally, in peer group discussions participants who have grasped the idea can help explain it in an understandable way to those who have not. The facilitator, by listening in on these discussions can also assess whether the group has understood the exercise. Participants will also be critical of each other's answers and signal nonsensical responses.

55. There are two in-between options that could be considered. First, the groups of participants could be stratified according to variables for which there are a prior to believe that they can influence risk perceptions. Possible stratifications could be based on age, wealth and experience in the activity. Second, the participants could be invited to a session where the whole exercise is explained and practiced in group, but individuals are then separated to draw their individualised distributions.

56. Often qualitative research is criticised for the way it samples respondents. It is not uncommon for researchers to request the village leaders to appoint households that can participate in these exercises. Our experience showed that this created opportunity for elite capture. It is therefore advised that samples are constructed in a different fashion. The risk perception module is intended to supplement household data. It is therefore advisable to conduct it with the same households that participated in the survey, possibly stratified on the basis of data collected therein.

57. It would also be necessary to obtain cost information for each activity. For example, although we find that revenues from cassava outperform those of many other crops, participants pointed out that it would require quite an investment in terms of hiring labour to prepare the field if one were to plant a whole acre of cassava. Cost information would allow the researcher to plot expected profits, rather than expected revenues and would also be necessary to identify credit constraints.

58. We need a better understanding of the lower limits of the distribution, especially the probability of complete harvest failure. For example cassava harvests have failed in a major way in previous years due to the cassava mosaic disease. It is not unlikely that participants considered the chance of getting 0 in the cassava 0-1 interval higher than getting 0 in the banana 0-3 interval. In future work the chance of complete harvest failure should be better understood. In the same spirit it would be insightful to get better delineations of the levels at which the household considers to have surplus production over its own consumption needs.

59. For an overall risk assessment one would ideally want to complement these data with some basic insights in the covariance between the different activities. Yields of some crops may be highly covariant in the face of a drought, but not in the face of disease. E.g. beans and maize are likely to be very similarly affected by rain, while cassava yields are relatively independent of rain, but affected by a disease that has no direct influence on other activities. It may be possible to collect such data directly from the farmer in a module similar to the one suggested in this paper. Similarly, information is needed on the degree with which increased investment in one crop implies decreased investment in another one. For example, although beans were reported to be ‘dominated’ by sweet potatoes, the two crops are farmed on very different types of plots and may require labour inputs at different times of the year. Thus, they are not competing with each other, at least not on these two factor markets, which would make growing both crops consistent with our findings.

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