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ABSTRACT

Keep Up With the Winners: Experimental Evidence on Risk Taking, Asset Integration, and Peer Effects

The paper reports the result of an experimental game on asset integration and risk taking. We find evidence that winnings in earlier rounds affect risk taking in subsequent rounds, but no evidence that real life wealth outside the experiment affects risk taking. We find some evidence of imitation of the risk taking behavior of others that is distinct from learning. Controlling for past winnings, participants who receive a low endowment in a round engage in more risk taking. We also test a `keeping-up-with-the-Joneses' hypothesis and find some evidence that subjects seek to keep up with winners. Taken together, the evidence is consistent with risk taking tracking a reference point that is affected by social comparisons.

JEL Classification: C91, D12 and D81
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1. Introduction

In spite of a voluminous literature in psychology and economics, risk taking decisions remain poorly understood. This is unfortunate given how critical risk taking is to all important economic decisions – from investment to innovation, schooling, and finance. In this paper we use an original experiment to revisit a key issue that potentially affects risk taking: asset integration. This refers to the idea that individuals make decisions about risky prospects by considering the effect of decisions on their final wealth rather than on specific gains and losses (Kahneman and Tversky 1979). We focus on two kinds of asset integration: (1) integration of winnings between successive tasks within an experiment; and (2) integration of winnings with real life wealth outside the experiment. We also look at other factors that may affect risk taking: individual dynamic effects such as learning, hot hand effect, and gambler's fallacy; and peer dynamic effects such as imitation, learning from others, and invidious comparisons.

There is evidence that participants in experiments make risk taking decision 'as in a bubble', that is, ignoring their existing non-experimental assets.[1] Perhaps the most convincing evidence of the failure of asset integration is the observation that participants in laboratory experiments often shy away from profitable lotteries involving small absolute payoffs relative to their wealth (Rabin and Thaler 2001). If participants integrated lottery stakes with their total wealth when considering what choices to make, only individuals with extremely high risk aversion would avoid such small but profitable lotteries. One way of solving this paradox is by assuming that individuals keep their total wealth and experimental income mentally separate when making decisions, which amounts to postulating a lack of asset integration (Cox and Sadiraj, 2006). That this may be the case was already implied by the risk attitude estimates of Binswanger

[1] E.g., much of the evidence in favor of prospect theory or other non expected utility theories relies on changes of income as opposed to final states. Broadly speaking, this evidence can be interpreted as violating asset integration (see, for example, Battalio et al. 1990 for a similar interpretation).

(1981) and Gertner (1983), and has most recently been claimed by Schechter (2007). We are aware of only one published study (Andersen et al. 2011) that directly tests whether asset integration is present using a combination of survey data and experimental risk taking data from four single shot tasks. They find some evidence of only partial asset integration.

We revisit this issue using results from a multiple round experiment and test whether or not people integrate winnings between successive rounds of the same experiment. In each round, participants are offered an initial endowment for that round. Participants receive either a high or a low endowment in each round; this is common knowledge among participants in the same group of six subjects, three of which have high and the remaining three low endowments. From this endowment, participants are asked how much they wish to 'invest' in a lottery that yields, with equal probability, 0 or three times the amount invested. In the context of the experiment, risk taking is represented by the share of their endowment that players invest in the lottery. We take advantage of the fact that players are faced with the same decision three times in a row to investigate dynamic individual and peer effects.

We begin by showing that risk taking within the experiment is uncorrelated with the assets that participants hold outside the experiment, i.e., there is failure of integration with real life assets. We do, however, find that winnings from earlier rounds of the experiment affect risk taking. This suggests that participants integrate past experimental winnings with lottery stakes when choosing how much risk to take: the larger past winnings are, the more risk participants take.[2] The combination of these two results suggests that the extent to which individuals integrate assets when making risky decisions depends on the context. More specifically, our results are consistent with narrow framing: what happens during the experiment is regarded by

[2] The fact that the effect is positive is consistent with expected utility and positive prudence (Kimball 1990), but can also be explained by other models of risk taking such as prospect theory.

participants as being in a different frame from their daily lives.[3]

We also test whether risk taking in a round depends on whether participants received a high or low endowment in this round. In an expected utility framework, the effect of a high endowment is predicted to be the same as that of past winnings, i.e., positive with an equal coefficient. This is not what we find: participants who receive a high endowment in a round invest a smaller share of it in the lottery than those who receive a low endowment, controlling for past winnings. This suggests that participants who receive a low endowment in a round try to make up for it by taking more risk – an effect we dub 'keep-up-with-the-winners', that is, those who were lucky enough to receive a high endowment in the round. This effect can be understood as an application of prospect theory to our experimental setting, and suggests that reference points are affected by what endowment participants receive at the beginning of each round.

Our experimental design enables us to explore other dynamic effects at the individual and group level. Exploiting the fact that participants make repeated choices after observing their past lottery outcomes, we verify whether we observe either a 'hot hand' effect – by which participants who win lotteries become more risk taking controlling for experimental earnings – or a 'gambler's fallacy' – by which participants instead engage in less risk taking following a win. Croson and Sundali (2005) find some evidence of both in data from a Las Vegas casino.[4] Some of our coefficient point estimates are consistent with the gambler's fallacy, but results are not statistically significant.

We also explore the existence of peer effects. At the end of each experimental round, partici-

[3] This is an example of 'choice bracketing' as discussed by Read et al. (1999).

[4] Regarding the 'hot hand' effect, one explanation of this would be that participants are learning about the nature of the risk: although participants are told the odds of winning the lottery, they may not fully believe what they were told. In this case, winning in an early round may incite them to revise their beliefs upwards, thereby encouraging them to take more risk in subsequent rounds. An alternative justification for this is that people believe they are on a 'lucky day'. In relation to the gamber's fallacy, participants may believe that probabilities of winning are not independent: having won once, they perceive that their chance of winning again has fallen.

pants observe the winnings and investment decisions of other players. We examine whether risk taking is affected by how much others invested and won. There are several possible channels by which these may influence risk taking. One possible channel is learning from others: observing others winning may incite participants to revise upwards their beliefs about their own probability of winning, encouraging more risk taking. Given our experimental design, the probability of winning is in principle known. Unless participants doubt what researchers told them, learning is unlikely and this is what we find: participants do not take more risk when they observe others winning the lottery.

Another possible channel is imitating the behavior of others, perhaps because participants seek to conform to emerging social norm of risk taking within the experiment.[5] This may be reinforced if subjects unfamiliar with the decision environment imitate others as a way of economizing on problem solving. Imitation may also arise from a desire to mimic what others do – e.g., to 'follow the fashion' – perhaps due to appropriately specified relative utility preferences (Clark and Oswald 1998). Imitation, whatever the reason, predicts own risk taking to be influenced by the risk taking of others in earlier rounds. We find some evidence of imitation, but it is not robust.

Risk taking may also be influenced by observing the winnings of other participants – which is the combination of how much risk they take and whether they are lucky or not. Experimental subjects may enter in an implicit competition with each other: when others win big, the only way to keep up with them is to take more risk. We find some evidence for this in round 2, an effect that can be seen as consistent with the 'keep-up-with-the-winners' effect.

We also investigate whether participants respond to social comparisons, that is, behave in

[5] A good overview on social norms and conformism is contained in Zafar (2011). There are a number of econometric studies that have found evidence of peer effects in the context of behavior that may be construed as involving risk taking, such as substance abuse, smoking and criminal activity: Case and Katz (1991), Kawaguchi (2004), Powell et al. (2005) and Lundborg (2006) are four examples.

a way that is similar to 'keeping up with the Joneses' in the consumption domain (Duesenbery 1947).[6] One simple way of modelling this is by assuming that the reference point or aspiration level is a function of what others earn on average: if participants are falling behind the average of their peers, they then take more risk – up to the point where they are above the average.[7] As we illustrate in the conceptual section, the relationship between wealth and risk taking need not be linear in models with relative utility (see Robson, 1992). This is because the 'keep-up-with-the-Joneses' effect operates differently depending on whether the participant's own winnings are above or below those of others. We test this prediction and find no evidence of such an effect: risk taking does not respond to an individual's winnings relative to the average.

Taken together, the results indicate that experimental subjects take relative experimental earnings into account when deciding how much risk to take: they seek to compensate for a low endowment in a round by taking more risk, and they take more risk if other players in their group won more than them in some rounds. This behavior is consistent not so much with 'keeping up with the Joneses', that is, the average, but rather with taking risk to keep up with the winners of the experiment, the high income earners. This suggests that participants take high earners as reference point or aspiration level when deciding how much risk to take. It therefore appears that, in this experiment at least, risk taking has a competitive element, even in a context where participants are quite poor and where the potential earnings from the experiment are large relative to their wealth or income. This suggests that risk taking behavior cannot be understood as a purely individual decision without strategic considerations, as is done in most of the literature.

[6] There is also a connected literature looking at the relationship between risk-taking and inequality in tournaments, which could have social status as prizes (see Becker et al. 2005; Hopkins and Kornienko 2010; Hopkins 2011).

[7] To have this result, we either need to assume either standard loss aversion combined with greater risk taking in the domain of 'losses' relative to the reference point such as may be assumed, e.g., in cumulative prospect theory (Tversky and Kahneman 1992), or we need to assume an aspiration level type of model such as Lopes and Oden (1999) and Genicot and Ray (2010). The two sets of models may be related (Rieger 2010).

2. The experiment

We conducted an experiment in Ethiopia in four rural villages, mainly with farmers, and with university students in the capital city, Addis Ababa. The rural fieldwork was conducted between February and March 2009. The four villages are located in different agro-ecological regions of the country. The games with university students took place in February 2010. The experiment is based on earlier experiments organized by Zizzo (2003) and Zizzo and Oswald (2001) in a laboratory setting.

The experiment requires participants to repeatedly make the same risky choice. This enables us to examine whether choices evolve over time as a function of each participant's past winnings and information set. This aspect of the data is the focus of this paper.[8]

The design of the experiment is as follows. Thirty individuals participate in a session and these players are divided into five groups with six players in each, equally divided into high and low income players. Anonymity within each group is strictly maintained even though the thirty participants in a session can see each other. Each player plays three rounds. At the start of each round players are randomly given either a high (Ethiopian Birr 15) or a low (Birr 7) endowment to induce inequality.[9] Each participant then decides how much of this endowment to invest in a more than actuarially fair lottery with a 50% chance of winning thrice the amount invested. After lottery winnings are determined, players are informed of the winnings of the other five members of their group and how much they themselves have won from the lottery.[10]

[8] The experiment also allows participants to destroy, at a cost, other players' payoff. This aspect relates to a literature studying the so-called 'money-burning' experiments and is the focus of a companion paper (Kebede and Zizzo 2011). In the money burning stage players observe the winnings of other participants in their group of six players, and they are allowed to decrease the earnings of others at their own cost.

[9] The Birr is the national currency of Ethiopia and at the time of games the exchange rate was around 8 Birr for 1 US $.

[10] At this point all six members of a group are given the option to destroy some of the winnings of others in their group. Players have to pay from their own money one tenth of the amount they wish to destroy. After eliciting the decision of each participant, the choice of one of the six members of the group is randomly selected and applied. This aspect of the experiment is not the focus of this paper but is discussed in Kebede and Zizzo (2011). In practice, few participants experience the destruction of their winnings by others.

The game is repeated three times. In each round new groups are formed with different participants. Players are informed about this. At the end of the game, participants leave with all the winnings accumulated over the three rounds plus a participation fee. This was implemented in four rural villages with a total number of 240 participants, and with 60 university students in the city of Addis Ababa. In addition, a slightly different version of the game was played with another 60 students. In this version, participants stay in the same group of six players over the three rounds. We call this treatment the fixed group treatment.

3. Testing strategy

We now introduce the econometric testing strategy. After presenting our notation, we explain how we test whether participants integrate their assets or past winnings when deciding how much risk to take. We then introduce social comparisons. At the end of the section we discuss how we address possible confounding effects induced by imitation and learning.

3.1. Notation

Let Z_{it} be the initial endowment given to player i in round t, with $Z_{it} = \{7, 15\}$. Let X_{it} denote how much of this endowment player i invests in the lottery in round t. The amount not put at risk is $Z_{it} - X_{it}$. Individuals with a smaller initial endowment Z_{it} can invest less. We define x_{it} as the proportion of Z_{it} that is invested:

$$x_{it} = \frac{X_{it}}{Z_{it}}$$

Clearly, $0 \leq x_{it} \leq 1$. Given that only integer values of X_{it} are allowed in the experiment, x_{it} can only take a finite – but not negligible – number of values. Let Y_{it} denote the return on the risky investment. It takes two values with equal probability: $Y_{it} = \{0, 3X_{it}\}$.

This game is played for three successive rounds in groups of six players. In one treatment, the six players are the same throughout. In another treatment, the six players change in each round. At the end of each round, players are told how the other members of their group played and how much money they earned. In other words, they are told Z_{it}, X_{it} and Y_{it} for all five other players. Let W_{it} denote the winnings of player i in round t. In general $W_{it} = Z_{it} - X_{it} + Y_{it}$.[11]

3.2. Risk taking

We first examine decisions when players regard each round of the game in its own narrow frame. With no asset integration with earlier rounds, all three rounds for player i are identical and the decision in each round is of the form:

$$\max_{0 \leq X_t \leq 1} \frac{1}{2} U(Z_t - X_t) + \frac{1}{2} U(Z_t + 2X_t) \tag{3.1}$$

This shows that X_t is a function of Z_t only, not of earlier winnings. In linear form we have:

$$X_{it} = a + bZ_{it} + u_{it} \tag{3.2}$$

If players have constant relative risk aversion, x_{it} is a constant proportion of Z_{it} and $X_{it} = bZ_{it} + u_{it}$.[12] It is widely believed that relative risk aversion (RRA) is either constant or mildly

[11] When some of i's winnings are destroyed by another player, we subtract this amount from i's winnings from the round and we subtract the corresponding cost from the other player.

[12] To demonstrate, let $U(c) = \frac{c^{1-r}}{1-r}$ where r is the coefficient of relative risk aversion. The optimal choice of risk taking x in our experiment is the solution to

$$\max_x \frac{1}{2} \frac{Z^{1-r}(1-x)^{1-r}}{1-r} + \frac{1}{2} \frac{Z^{1-r}(1+2x)^{1-r}}{1-r}$$

The first order condition is:

$$\frac{1}{2} Z^{1-r} \left[-(1-x)^{-r} + \alpha(1+\alpha x)^{-r} \right] = 0$$

where Z factors out. Simple algebra yields:

$$x = \frac{1 - 2^{-\frac{1}{r}}}{1 + 2^{1-\frac{1}{r}}}$$

decreasing – in which case x_{it} increases with Z_{it}. In contrast, increasing relative aversion implies that x_{it} falls with Z_{it}. Given the small range of variation of Z_{it} relative to participants' wealth, we expect relative risk aversion to be approximately constant with Z_{it} – and hence x_{it} to be constant over the range of Z_{it}. Constant relative risk aversion thus requires that $a = 0$ and $b > 0$ while decreasing relative risk aversion is implied by $a < 0$.

A positive a implies increasing relative risk aversion over the narrow range of values taken by Z_{it}, something that is a priori unlikely among poor subjects. It is also difficult to reconcile $b = 0$ with expected utility. We revisit these issues below when we introduce reference points and loss aversion.

3.3. Asset integration

Keeping within the expected utility framework for now, we want to test whether players integrate their winnings from earlier rounds W_{it-1} with lottery payoffs when choosing X_{it}. If players fully integrate their winnings over the entire experiment, then the utility of each player i in the last round will be a function of the winnings from all rounds $U_i\left(\sum_{t=1}^{3} W_{it}\right)$. Dropping the i subscript to improve readability, the decision in the last round is:

$$\max_{0 \leq X_3 \leq 1} \frac{1}{2} U(W_1 + W_2 + Z_3 - X_3) + \frac{1}{2} U(W_1 + W_2 + Z_3 + 2X_3) \tag{3.3}$$

where W_1, W_2 and Z_3 are then predetermined. By analogy with (3.2), we expect risk taking to approximately follow:

$$X_{i3} = a_3 + b_3(W_{i1} + W_{i2} + Z_{i3}) + u_{i3} \tag{3.4}$$

with $b_3 > 0$. If participants have constant relative risk aversion, $a_3 = 0$.

We see that x does not depend on Z, tends to 1 when r approaches 0, and falls as r increases.

Whether or not players integrate past winnings with Z_{i3} can thus be investigated by estimating a model of the form:

$$X_{i3} = a_3 + b_3'(W_{i1} + W_{i2}) + b_3 Z_{i3} + u_{i3} \tag{3.5}$$

If players fully integrate their winnings, $b_3' = b_3 > 0$; if they only partially integrate their winnings, we should observe $b_3 > b_3' > 0$. If they don't integrate winnings at all, $b_3' = 0$.

A similar test can be estimated for the second round. The optimization problem in the second round is:

$$\max_{0 \le x_2 \le 1} \frac{1}{2} EV(W_1 + Z_2 - x_2 Z_2 + Z_3) + \frac{1}{2} EV(W_1 + Z_2 + 2x_2 Z_2 + Z_3) \tag{3.6}$$

where the expectation E is taken over future values of Z_3.[13] The same reasoning applies: if players integrate their past winnings when making decisions, then choices should approximately follow a regression model of the form:

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + u_{i2} \tag{3.7a}$$

with $b_2' = b_2 > 0$ while if they do not integrate, then $b_2' = 0$. This can be tested in the same manner as described for (3.5). Equation (3.7a) and (3.5) form the starting point of our estimation strategy.

By the same reasoning, if players integrate their actual wealth A_i with lottery winnings when deciding X_{it}, we expect X_{it} to increase with A_i. This can be investigated by estimating a model

[13] Here $V(.)$ denote the value of the solution to (3.3). $V(.)$ inherits much of its curvature from $U(.)$ itself (Deaton 1991).

of the form:

$$X_{i1} = a_1 + b_1 Z_{i1} + cA_i + u_{i1} \tag{3.8}$$

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + cA_i + u_{i2} \tag{3.9}$$

$$X_{i3} = a_3 + b_3'(W_{i1} + W_{i2}) + b_3 Z_{i3} + cA_i + u_{i3} \tag{3.10}$$

and test whether $c > 0$. If A_i is expressed in the same units as winnings W_{it}, we can also test whether $c = b_t' = b_t$ to test whether integration is complete or partial, as in Andersen et al. (2011). With asset integration, the optimal X_{it} may exceed Z_{it}, however. Given this, we also estimate the model using tobit with upper limit censoring given by Z_{it}.

3.4. Social Comparisons and Relative Utility

According to prospect theory, risk taking behavior differs depending on whether the decision maker is below or above his/her reference point (Kahneman and Tversky 1979). Above the reference point, individuals are predicted to behave in the standard risk averse fashion. Below the reference point, individuals may behave in a risk neutral or risk loving manner. There is also a kink at the reference point, generating strong risk aversion when choosing between prospects just above and below the reference point. The largely unanswered question is what the reference point is. If the reference point responds to what happens to peers, this opens the door to other types of peer effects.

3.4.1. Reference point

We begin by discussing how behavior predictions differ when risk taking decisions are taken in comparison to a reference point. To illustrate the role of reference points in a simple manner, consider a piecewise linear utility with reference point M and loss aversion coefficient η with

$0 < \eta < 1$. More complex utility functions have been proposed in the literature, but given the simplicity of our experiment this one suffices.[14] Let utility be written:

$$U(C) = C - \eta I(C > M)(C - M)$$

where $C > 0$ denotes payoff, $I(C > M)$ is an indicator function, and parameter η captures how strong the kink is at $C = M$. We have $U(C) = C$ if $C < M$ and $U(C) = C - \eta(C - M)$ for $C > M$. If $M = 0$, utility is linear in payoff and the optimal $X_{it} = Z_{it}$: participants are risk neutral and are thus predicted to invest their entire endowment. Similarly, if M large enough $X_{it} = Z_{it}$ as well. For intermediate values of the reference point M, the kink in the utility function induces risk aversion, and $X_{it} < Z_{it}$.

In our experiment,[15] it can be shown that if $\eta > 0.5$ the relationship between x_{it} and the reference point M is decreasing in M up to a point and increasing above that. For $0 \leq M < Z_{it}$ the optimal choice of X_{it} is:

$$X_{it} = Z_{it} - M$$

At $Z_{it} = M$, $X_{it} = 0$: individuals whose endowment puts them at their reference point invest nothing. This is because, when $\eta > 0.5$, the expected gain from risk taking is more than cancelled by the reduction in utility above M. If we keep increasing M above Z_{it}, however, we move away from the kink at M and X_{it} starts increasing again as utility approaches risk neutrality.

(Figure 1 around here)

In Figure 1 we plot x_{it} against M for endowments $Z_{it} = 7$ and 15, respectively.[16] We see that, when the reference point M is below 10, x when $Z = 7$ is less than when $Z = 15$, i.e., players who

[14] Given that in our experiment probabilities always are 50%, we ignore issues of probability weighting, which tend to affect choices at low and high probabilities only.

[15] The cutoff value of η is driven by the fact that in the experiment the expected gain from investing is 0.5.

[16] η is set to 0.9. Other parameters are those of the experiment.

receive a low endowment invest proportionally less. In contrast, for values of $M > 10$, individuals who receive a low endowment invest proportionally *more* in the lottery. The intuition is that players who judge their payoff relative to a relatively high reference point seek to make up for their low endowment by taking more risk. This kind of prediction is difficult to reconcile with standard expected utility theory. Hence, in the context of our experiment, finding that x_{it} is higher for $Z_{it} = 7$ than for $Z_{it} = 15$ is prima facie evidence against the expected utility model – and suggests that participants choose something close to the high endowment as reference point.

3.4.2. Keeping up with the winners

The literature on social comparisons and relative utility does not focus on risk taking but discusses the ways in which others' payoff may influence utility directly. Many of them do not predict an effect of social comparisons on risk taking. [17] One form of social comparison relevant for risk taking, however, is the 'keeping up with the Joneses' effect proposed by Duesenbery (1947) in the context of consumption and saving. Applied to risk taking, it predicts that people do not wish to perform less well than their peers. This can be formally represented by letting the performance of peers affect reference point M. As illustrated in Figure 1, x_{it} increases in M over much of its range. Hence, by raising M, peer effects may increase risk taking.

Within the context of our experiment, a 'keeping up' effect can arise in several possible ways. First, at the beginning of the game, participants first learn whether they receive a high or low

[17] In particular, risk taking is unaffected by any other-regarding preference modelled as a – multiplicatively or additively – separable term in the utility function. This includes Beckerian altruism and paternalistic preferences. Letting $\overline{W}_{-it} \equiv \sum_{j \in N_{it}} W_{jt}$, risk taking is also unaffected in an invidious utility function of the form:

$$U\left(\frac{\sum_{s=1}^{t} W_{it}}{\beta \sum_{s=1}^{t} \frac{1}{5}\overline{W}_{-it}}\right)$$

since the $\overline{W}_{-it}$ terms factors out of the coefficient of prudence. This functional form is the one most naturally associated with relative utility preferences studied e.g. by Clark and Oswald (1998).

Another way of writing these preferences is $U(W_{it} - \beta\overline{W}_{-it})$. But with such preferences, risk taking falls with other players' winnings, which is the opposite of the 'keeping up with the Joneses' effect we discuss below.

endowment Z_{it}. By design, those who receive a low Z_{it} know that others in their group received a high Z_{it}. This is because, within each group, three players receive a low Z_{it} and three receive a high Z_{it}. If participants set the high Z_{it} (the endowment of 15 received by the 'winners') as their reference point, we expect more risk taking for recipients of a low Z_{it}. This is illustrated in Figure 1 which shows that, for M larger than 10, x_{it} is larger for recipients of the low Z_{it}.

This possibility can be investigated by comparing risk taking x_{it} between recipients of a low and high endowment Z_{it}. As discussed earlier, it is difficult to account for a much higher x_{it} for $Z_{it} = 7$ than $Z_{it} = 15$ within an expected utility framework. But it is consistent with loss aversion and a reference point above 10. Finding such evidence would therefore suggest that participants seek to keep up with the 'winners' of a high endowment in the round by taking more risk in that round. Since by design in each group half of the subjects receive a low endowment and half receive a high endowment, recipients of a low endowment of 7 must invest relatively more to keep up with the winners of high endowment of 15.

A second possible source of 'keeping up' effect comes from the fact that, at the end of a round, participants observe the winnings of others $G_{-it} \equiv \sum_{j \in N_{it}} 3x_{jt}Z_{jt}r_{jt}$ where r_{jt} is j's lottery realization in round t.[18] Observing that others have won more in earlier rounds may raise i's reference point, thereby inducing i to take more risk in subsequent rounds to keep up with the winners of earlier rounds. This can be investigated by estimating a model of the form:

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + \kappa_2 G_{-i1} + u_{i2} \tag{3.11}$$

$$X_{i3} = a_3 + b_3' (W_{i1} + W_{i2}) + b_3 Z_{i3} + \kappa_3 G_{-i2} + u_{i3} \tag{3.12}$$

[18] To recall, $r_{it} = \{0, 1\}$ with equal probability.

where we control for learning and imitation to avoid spurious inference. Keeping up with lottery winners in past rounds would manifest itself by positive values of b_2 and b_3 as well as positive κ_2 and κ_3. We call both effects 'keeping up with the winners'.

Another possibility, arguably more in line with the literature on peer effects, is that people do not wish to perform less well than the *average* of their peers. We call this effect 'keeping up with the average' – or 'keeping up with the Joneses' by reference to Duesenbery's (1947) work on consumption and saving. Here the behavioral objective is not winning but rather *not* losing.

To formalize this idea, let $\overline{W}_{-it}$ be the average winnings of the players i could observe in earlier rounds. One possible way of testing the 'keeping up with the average' hypothesis is to replace G_{-it} with $\overline{W}_{-it}$ in regression models (3.11) and (3.12). Unlike G_{-it} (and a high Z_{it}), however, $\overline{W}_{-it}$ need not be above 10. This opens the possibility that the relationship between X_{it} and $\overline{W}_{-it}$ is non-monotonic. To verify the robustness of our finding with respect to this possibility, we estimate a version of models (3.11) and (3.12) that uses x_{it} as dependent variable – to keep close to the model and Figure 1 – and that includes a quadratic term in i's past winnings relative to the average, i.e., in $R_{it} \equiv W_{it} - \overline{W}_{-it}$. The estimated model is of the form:

$$x_{it} = \beta_0 + \beta_1 R_{it} + \beta_2 R_{it}^2 + \beta_1 Z_{it} + v_{it} \tag{3.13}$$

Keeping up with the winners of a high endowment implies $\beta_1 < 0$: high endowment subjects invest proportionally less. As shown in Figure 1, keeping up with a reference point affected by the average of other players' past winnings implies a non-monotonic relationship with $\beta_1 < 0$ and $\beta_2 > 0$, centered around the hypothesized reference point $\overline{W}_{-it}$, that is, around $R_{it} = 0$.

3.5. Possible confounding effects

For the testing strategy outlined above to be convincing, we need to rule out possible confounding effects. Two possibilities are particularly relevant in our case: learning and imitation. Fortunately, the structure of the experiment is such that we can test for these effects directly.

3.5.1. Learning

If players revise their prior about winning the lottery based on past experience, winning in early rounds may increase risk taking in subsequent rounds. In the experiment the true winning probability $\alpha = 0.5$, and this is the probability reported by the experimenter. It is nevertheless possible either that subjects do not believe the experimenter, or that winning makes them feel 'lucky' and lead them to believe that their own 'personal' α is above 0.5. In either case, we expect risk taking to increase when the participant won the lottery in earlier rounds, generating a possible confounding effect when testing for asset integration.

To investigate this possibility, let $s_{it} = 1$ if i wins in round t, $s_{it} = -1$ if i loses in round t, and $s_{it} = 0$ if i does not risk anything in round t, in which case there can be no learning from past play. Identification is achieved because s_{it} is not i's monetary winnings from earlier rounds, but a variable indicating whether i won or lost, irrespective of the risked amount X_{it}. If player i revises his/her prior based on winning or losing in earlier rounds, we expect:

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + d_2 s_{i1} + u_{i2} \tag{3.14}$$

$$X_{i3} = a_3 + b_3'(W_{i1} + W_{i2}) + b_3 Z_{i3} + d_3 \left(\frac{s_{i1} + s_{i2}}{2} \right) + u_{i3} \tag{3.15}$$

with $d_2 > 0$ and $d_3 > 0$.

Players may also revise their priors based on others' lottery outcomes. The logic is the same as above: if players use others' winning experience to revise their priors about α, they will increase risk taking when others win more. To investigate this confounding effect, let N_{it} denote the set of players that were in i's group in round t. We estimate:

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + d_2 s_{i1} + d_2' s_{-i,1} + u_{i2} \tag{3.16}$$

$$X_{i3} = a_3 + b_3'(W_{i1} + W_{i2}) + b_3 Z_{i3} + d_3 \left(\frac{s_{i1} + s_{i2}}{2} \right) + d_3' s_{-i,2} + u_{i3} \tag{3.17}$$

where $s_{-i,1} \equiv \frac{\sum_{j \in N_{i1}} s_{j1}}{5}$ and $s_{-i,2} \equiv \frac{\sum_{j \in N_{i2}} s_{j1} + s_{j2}}{10}$. If players revise their prior based on others' lottery outcomes, we should observe $d_2' > 0$ and $d_3' > 0$, and this can be tested directly since $s_{-i,1}$ and $s_{-i,2}$ are observed by the researcher.[19]

3.5.2. Imitation

Another possible confounding effect arises if players imitate the investment behavior of others. As discussed in the introduction, there are various reasons why players may seek to imitate what others do, such as mimicry, social pressure, or economizing on problem solving.[20] When others invest more they will, on average, have higher winnings since investment has a positive return. Hence imitating others could generate a correlation between others' winnings and investment that is not due to a keeping-up effect.

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[19] If there is learning and players regard others' outcomes as equally informative to their own, we should observe $d_2 = \frac{d_2'}{5}$ and $d_3 = \frac{d_3'}{5}$. This is because d_2' is the coefficient of the average outcome of five other players, and thus should carry five times as much weight as i's own outcome if players regard others' outcomes as informative as their own. In contrast, if player i only cares about own past winnings because they signal good luck, we should observe $d_2' = d_3' = 0$ since, in this case, whether others win contains no information about i's probability of winning.

[20] Indirect learning is unlikely since by design players observe (almost) all the information other players have, and can be controlled for directly through $s_{-i,1}$ and $s_{-i,2}$, as in (3.16) and (3.17). The only exception is in games when players are rematched into different groups in each round. In this case, other players have information from round 1 groups which is revealed in their round 2 behavior – and could influence play in round 3. To allow for this possibility, we estimate round 2 and round 3 imitation effects separately.

To illustrate, let's expand the utility function to include a concern μ for imitation, e.g.:

$$U_i\left(\sum_{s=1}^{t} W_{is}\right) + \mu \left|X_{it} - \overline{X}_{-i,t-1}\right|$$

where μ is an imitation preference parameter, and $\overline{X}_{-i,t-1}$ denotes the average risk taking behavior of others in the group, as revealed by previous rounds, i.e.:

$$\overline{X}_{-i,t} \equiv \sum_{j\in N_{it}} \sum_{s=1}^{t} \frac{1}{5t} X_{js}$$

Players with this utility function adjust their risk taking behavior to imitate that of others, i.e., so that their X_{it} is close to $\overline{X}_{-i,t-1}$. This can be investigated using a regression of the form:[21]

$$\begin{aligned} X_{i2} &= a_2 + b_2' W_{i1} + b_2 Z_{i2} + \mu_2 \overline{X}_{-i,1} + u_{i2} \\ X_{i3} &= a_3 + b_3'(W_{i1} + W_{i2}) + b_3 Z_{i3} + \mu_3 \overline{X}_{-i,2} + u_{i3} \end{aligned}$$

with $\mu_2 > 0$ and $\mu_3 > 0$.

To disentangle imitation from learning, we can control for learning directly as in (3.16) and

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[21]

$$\begin{aligned} \overline{X}_{-i,1} &= \frac{1}{5} \sum_{j\in N_{i1}} X_{j,1} \\ \overline{X}_{-i,2} &= \frac{1}{10} \left(\sum_{j\in N_{i1}} X_{j,1} + \sum_{j\in N_{i2}} X_{j,2} \right) \end{aligned}$$

(3.17) by including $s_{-i,1}$ and $s_{-i,2}$:

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + \mu_2 \overline{X}_{-i,1} + \gamma_2 s_{-i,1} + u_{i2} \tag{3.18}$$

$$X_{i3} = a_3 + b_3' (W_{i1} + W_{i2}) + b_3 Z_{i3} + \mu_3 \overline{X}_{-i,2} + \gamma_3 s_{-i,2} + u_{i3} \tag{3.19}$$

If there is imitation but no learning, once we control for $\overline{X}_{-i,1}$ or $\overline{X}_{-i,2}$, whether others won or not should not matter: we expect $\mu_2 > 0$ and $\mu_3 > 0$ but $\gamma_2 = \gamma_3 = 0$. In contrast, if participants imitate others because of what their behavior reveals about the probability of winning α, we expect $\gamma_2 > 0$ and $\gamma_3 > 0$ as in (3.16) and (3.17).

4. The data

In Table 1 we present descriptive statistics on participants from the four rural sites and for university students. Most participants are males but the proportion of males rises to 90% in the case of university students. Unsurprisingly, the average age of rural participants is higher than that of students.

(Table 1 around here)

On average university participants take more risk: they invest a little over half of their initial endowment in the lottery, which is nearly twice as much as rural players; and the cumulative distribution of investment rates among students is everywhere above that of rural participants. University participants invest their entire endowment in 22% of the games compared to 3% of rural participants. Less than 1% of students invest nothing on lottery compared to 8% of rural participants. Hence, we clearly see higher risk taking among students compared to rural participants. If we assume, as is reasonable in the Ethiopian context, that university students have a higher permanent income, this constitutes prima facie evidence that income affects risk taking. Of course, other factors could also be responsible for this difference. Since taking risk is profitable in our experiment, it is not surprising to find that the lottery winnings of the students are on average higher than that of rural participants.

Rural participants are covered by earlier household surveys from which we recover the value of their household assets. There is a lot of variation in wealth and expenditure within the participating rural population, as is clear from Table 1. Since there is no corresponding survey of university students, there is no information on their household assets.

There is no variation in the educational level of university participants as all of them are in higher education. Rural participants are more representative of the Ethiopian adult population, with much lower education levels. Half of rural participants have no formal education and more than 80% have at most incomplete primary education.[22] Although vocational skills may increase agricultural productivity, only 2% of rural participants have any form of vocational training.

The heterogeneity of the country in terms of religious beliefs is reflected in the subject population. In both sites, the traditional Ethiopian Orthodox faith is the most common, followed by Protestantism. Muslims are underrepresented compared to the Ethiopian population at large.

5. Empirical results

5.1. Asset integration

We begin by estimating our baseline regressions:

$$X_{i1} = a_1 + b_1 Z_{i1} + u_{i1} \tag{5.1}$$

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + u_{i2} \tag{5.2}$$

$$X_{i3} = a_3 + b_3' (W_{i1} + W_{i2}) + b_3 Z_{i3} + u_{i3} \tag{5.3}$$

[22] These figures are much lower than current school enrolment figures among the young.

Before doing so, we must deal with a potential endogeneity problem with respect to past winnings W_{i1} and W_{i2}. By design

$$W_{it} = Z_{it} - X_{it} + 3X_{it}r_{it} = Z_{it} + X_{it}(3r_{it} - 1) \tag{5.4}$$

where r_{it} is i's lottery realization in round t. To recall, $r_{it} = \{0, 1\}$ with equal probability. It follows that less prudent participants who invest more – i.e., have a higher X_{it} – also have higher winnings W_{it} on average. This could generate a spurious correlation between risk taking X_{i2} and X_{i3} and W_{i1} and W_{i2} that is driven by risk preferences, not by wealth effects within the experiment.

To eliminate this spurious correlation, we construct measures of W_{i1} and W_{i2} that depend on i's initial endowment in the round Z_{it} and i's lottery realization $r_{it} = \{0, 1\}$ but not on i's past investment decisions X_{i1} and X_{i2}. These measures, which we denote $\widehat{W}_{i1}$ and $\widehat{W}_{i2}$, are constructed by replacing, in formula (5.4), i's actual investment X_{it} with the average investment of players who, in the same round t and site v, received an endowment Z_{it}. Let $X(Z_{it}, v, t)$ denote this average. The formula we use through the analysis is thus:[23]

$$\widehat{W}_{it} = Z_{it} + X(Z_{it}, v, t)(3r_{it} - 1) \tag{5.5}$$

Accumulated winnings $\widehat{W}_{i1}$ and $\widehat{W}_{i1}$+ $\widehat{W}_{i2}$ are used as regressors in baseline regressions (5.2) and (5.3), respectively.

Results are presented in Table 2. All standard errors are clustered by player groups that

[23] One complication arises when individual i did not invest anything. In this case r_{it} is not observed. There are 82 such cases in the data. For these, we reconstruct ex post what r_{it} might have been simply by flipping a coin. This procedure introduces some noise in the wealth measure. But it is better than the alternative of replacing, for these individuals, $3r_{it} - 1$ with its expectation $E[3r_{it} - 1] = 0.5$. If we used the latter approach, the resulting wealth measure $\widehat{W}_{it}$ would be affected by i setting $X_{it} = 0$, and thus would still suffer from endogeneity.

constitute independent observations.[24] The first three columns of Table 2 refer to decisions made in the first round of the game (equation 5.1). Here the focus is on regressor Z_{i1}, the income that participants received at the beginning of round 1. This variable only takes two values, 7 and 15. Columns 4 to 6 focus on round 2 (equation 5.2) while columns 7 to 9 focus on round 3 (equation 5.3). In addition to the endowment players receive at the beginning of the round, they also include past winnings $\widehat{W}_{i1}$ (equation 5.2) and $\widehat{W}_{i1} + \widehat{W}_{i2}$ (equation 5.3).

(Table 2 around here)

We report three versions of each regression with different controls. The first version (columns 1, 4 and 7) only includes the above mentioned regressors plus dummy variables for each of the experimental sites to control for differences in average attributes across sites. The second version (columns 2, 5 and 8) adds controls for whether the composition of the groups was the same across rounds or not, and for whether the experimental session took place in the afternoon – to control for possible mood effects correlated with time of day (e.g., Coates and Herbert 2008). As further robustness check, the third version (columns 3, 6 and 9) adds individual controls such as age, gender, education and religion which may be correlated with risk taking.

Results are broadly consistent across the three sets of regressions: b_1, b_2 and b_3 are all small but positive (b_1 and b_2 significantly so), and b'_2 and b'_3 are significantly positive in all regressions: higher endowment in the round and higher winnings in earlier rounds of the experiment increase risk taking. Further, the point estimate of b'_2 is approximately half of b_2, a much larger relative effect than that reported by Andersen et al (2011) for outside wealth. As shown at the bottom of the Table, we cannot reject the full integration hypothesis that $b_2 = b'_2$ and $b_3 = b'_3$. Risk taking itself, however, is quite low: in rounds 1, 2 and 3, subjects invest on average 14, 10 and

[24] In the game version with fixed groups played in the urban area, membership of the groups is not changed between rounds, hence we cluster standard errors by the five groups formed within a session. In the version of the game with variable groups where players are re-matched in each round, we cluster standard errors by session.

5 cents for each additional Birr of endowment they receive in the round.

What can we say about relative risk aversion? Since a_1, a_2 and a_3 are all significantly positive, subjects invest a larger proportion x_{it} of their endowment when it is small. For instance, if we consider column (1), we see that students in round 1 invest on average $4.017 + 0.142 \times 7 = 5.011$ when they receive an endowment of 7 ($x_1 = 72\%$) and $4.017 + 0.142 \times 15 = 6.147$ when they receive an endowment of 15 ($x_1 = 41\%$). This indicates negative prudence – and hence risk loving preferences at low levels of Z_{it}. To confirm these findings, we report in Figures 2 and 3 the cumulative distribution of x_{it} and X_{it} for the two levels of Z_{it} across the sample. We see that the distribution of x_{it} for $Z_{it} = 7$ stochastically dominates that for $Z_{it} = 15$. We also note that b falls across rounds, suggesting less risk taking at the margin in later rounds of the experiment when subjects have accumulated more earnings. Such findings are difficult to reconcile with an expected utility framework, with or without asset integration.

(Figure 2 around here) (Figure 3 around here)

The rest of Table 2 checks the robustness of these findings to the inclusion of various controls. The fixed group dummy is negative, indicating less risk taking in groups with a fixed membership across all three rounds. We also find more risk taking in afternoon sessions. Why this is the case is unclear, but it may be due to diurnal variations in the endocrine system where the levels of testosterone and cortisol vary by time of the day (e.g., see Coates and Herbert 2008). Coefficients on Z_{it} for each round do not change with the addition of these controls while those on $\widehat{W}_{i1}$ and $\widehat{W}_{i1} + \widehat{W}_{i2}$ remain consistent in terms of significance and magnitude across regressions.

In columns 3, 6 and 9, we add controls for the participant's gender, age, education level, and religion. Risk taking varies systematically with some of these individual characteristics. Female participants, for instance, take on average less risk – which is consistent with the bulk of the experimental evidence to date (Croson and Gneezy 2009). Since individual characteristics are not randomly assigned and are likely to be correlated with socio-economic status, it is unclear how to interpret them. What is clear is that coefficients on Z_{it} and on $\widehat{W}_{i1}$ and $\widehat{W}_{i1}+\widehat{W}_{i2}$ remain virtually unchanged.

To investigate whether our results are an artifact of censoring, we reestimate Table 2 with a tobit estimator that allows for a lower limit of 0 and a variable upper limit Z_{it}. Results, not reported here to save space, are very similar to those in Table 2 in terms of coefficient magnitude and significance. This is hardly surprising given that few observations are at the upper limit of X_{it}: 4.2% of high endowment observations take value 15 and 14.8% of low endowment observations take value 7.

(Table 3 around here)

Next we test integration with household assets as indicated in regression models (3.8) to (3.10). In Table 3 our measure of actual wealth A_i is (the log of) household assets, as measured in a pre-existing household survey. The structure of the regressions is the same as in Table 2. We see that the coefficient of household assets is never statistically significant and remains small in magnitude. To check the robustness of this finding, we reestimate the regressions using for A_i the log of total household expenditures as proxy for permanent income. Results, presented in Table 4, are, if anything, worse: round 1 coefficients now have the wrong sign. Earlier findings from Table 2 are unchanged. This suggests that, contrary to Andersen et al. (2011) who report a small but significant effect of actual wealth on risk taking, we find no evidence that participants integrate their household assets with winnings from the experiment when choosing how much risk to incur.

5.2. Learning and imitation

Before turning to social comparisons, we devote some attention to possible confounding effects due to learning. We estimate regressions (3.14) and (3.15) with s_{i1} and $\frac{s_{i1}+s_{i2}}{2}$ included as additional regressors. Results are shown in Table 5. The format is the same as in earlier tables but only round 2 and 3 results are shown since it is only in these rounds that learning could have taken place. The coefficients of s_{i1} and $\frac{s_{i1}+s_{i2}}{2}$ are mostly negative but never statistically significant. The b_2' coefficient loses its statistical significance, possibly because past lottery outcomes enter the calculation of $\widehat{W}_{i1}$ and $\widehat{W}_{i2}$. To verify this interpretation, we reestimate Table 5 using actual winnings W_{i1} and W_{i2} instead of predicted winnings. With this change, the coefficients of W_{i1} and $W_{i1}+W_{i2}$ become significant again but the coefficients of s_{i1} and $\frac{s_{i1}+s_{i2}}{2}$ remain non-significant. From these results we conclude that there is no evidence of a hot hand or learning effect.

(Table 5 around here)

In Table 6 we further test whether participants learn from others using regression models (3.16) and (3.17) which include average past lottery outcomes $s_{-i,t}$ (i.e., proportion of wins) of i's group members in previous rounds. Estimated coefficients are positive in all cases, but never statistically significant. Perhaps this is not too surprising since in Table 5 we found no evidence of learning from one's own past observations.

(Table 6 around here)

In Table 7 we estimate regressions (3.18) and (3.19) to test whether participants imitate the average investment behavior $\overline{X}_{-i,t}$ of other players they have observed, controlling for learning from others through $s_{-i,t}$. We find a positive coefficient on the past investment of other players in i's group, and the coefficient is statistically significant in the two regressions without additional controls; statistical significance disappears once we include controls, perhaps due to loss of power.

We again find that $s_{-i,t}$ is not statistically significant in any of the regressions. From this we conclude that there is some evidence that participants imitate the risk taking behavior of others and that this imitation cannot be understood as driven by learning about the odds of winning the lottery. Other results on b_2, b_2', b_3 and b_3' are unchanged.

(Table 7 around here)

5.3. Social comparisons

Next we turn to social comparisons. We start in Table 8 with equations (3.11) and (3.12) in which we separately control for imitation $\overline{X}_{-i,t}$ and learning from self s_{it} and others $s_{-i,t}$. The estimated model is:

$$X_{i2} = a_2 + b_2' W_{i1} + b_2 Z_{i2} + \kappa_2 G_{-i1} + \mu_2 \overline{X}_{-i,1} + d_2 s_{i1} + \gamma_2 s_{-i,1} + u_{i2} \tag{5.6}$$

$$X_{i3} = a_3 + b_3'(W_{i1} + W_{i2}) + b_3 Z_{i3} + \kappa_3 G_{-i2} + \mu_3 \overline{X}_{-i,2} + d_3 s_{i2} + \gamma_3 s_{-i,2} + u_{i3} \tag{5.7}$$

in which G_{-it} represents the past winnings of players who were in i's group in the past:

$$G_{-it} \equiv \sum_{j \in N_{it}} 3 x_{jt} Z_{jt} r_{jt}$$

We control for the average past investment $\overline{X}_{-i,t}$ and the proportion of lottery wins $s_{-i,t}$ of peers to distinguish social comparison from learning and imitation. If participants seek to keep up with others' winnings, we expect $\kappa_2 > 0$ and $\kappa_3 > 0$. As shown in Table 8, coefficient estimates are positive and statistically significant for round 2 but not round 3. Participants increase their own risk taking when others in their round 1 group had large winnings, in line with a simple 'keep-up-with-the-winners' hypothesis where participants take more risk in an effort to catch up with others. We also note that, in round 2, the lottery outcomes of others $s_{-i,t}$ now appear with a negative significant sign. This confirms that it is the monetary winnings of others that matter, not whether the lottery was favorable to them.

(Table 8 around here)

Finally we test the 'keeping up with the average' social comparison model (3.13). To this effect, we define relative winnings R_{it} as

$$
\begin{aligned}
R_{i1} &\equiv \overline{W}_{-i1} - W_{i1} \\
R_{i2} &\equiv \overline{W}_{-i1} + \overline{W}_{-i2} - W_{i1} - W_{i2}
\end{aligned}
$$

and construct quadratic forms in R_{it} to approximate the V-shaped in Figure 1. This allows for the possibility that the social comparison effect operates differently depending on whether the participant's own past winnings are above or below the average of others. Keeping up with the average requires a negative linear term and a positive quadratic term. As explained in Section 2, x_{it} is the dependent variable.

Results are presented in Table 9. The coefficient on own endowment Z_{it} is significantly negative throughout, consistent with our earlier results: subjects invest proportionally more in the risky lottery when they receive a low endowment in a round. With respect to social comparisons, joint F-tests for R_{it} and R_{it}^2 are reported at the bottom of the table together with their significance. In the quadratic version of the model, estimated signs are as predicted by the social comparison model – $\beta_1 < 0$ and $\beta_2 > 2$ in (3.13) – but coefficients are never individually or jointly significant.

(Table 9 around here)

We also estimate a version of the model linear in R_{it}. If the average winnings of others

$\overline{W}_{-i1}$raise i's reference point well above that average, we may only observe the declining portion of Figure 1. As shown in Table 10, R_{it} has a significantly negative sign in 5 of the 6 regressions in linear form. This is consistent with a model in which subjects' reference point not only increases in the winnings of others but is also above the average winnings of others. In other words, subjects seem to want to keep up with *above average* players, that is, with the winners.[25]

(Table 10 around here)

6. Discussion and Conclusion

Using data on repeated risk taking in a sequential experiment, we have tested whether participants' behavior follows some commonly hypothesized patterns of behavior. The population we study is particularly suited to investigate risk taking because a large share of it faces considerable risk in their daily life and are constantly forced to make decisions under risk. Furthermore, because most of the study population is poor and subsistence oriented, the winnings from the experiment are large relative to participants' normal income. Based on this, we expect the behavior observed in our experiment to be more representative of the risk taking behavior of experienced individuals, as compared to undergraduate students for instance.

Our key findings can be summarized as follows:

1. Asset integration with total wealth: We find *no* evidence of asset integration between

[25] In addition to the various robustness checks already reported in the tables, we also investigate whether money burning affects our results. The concern is that money burning may be used by participants, among other possible purposes, in an effort to discourage deviant risk taking behavior. If so, participants whose winnings have been 'burned' in a previous round may be discouraged to invest in subsequent rounds, generating a negative correlation between risk taking and past exposure to money burning. Because money burning reduces winnings, it also generates the possibility of a spurious correlation between W_{i1} and W_{i2} and risk taking: victims of money burning have lower winnings, and take less risk because they have been chastised. Although money burning is fairly infrequent and is not the focus of this paper, we need to deal with this possibility.

To this effect, we test the robustness of our results to the inclusion of an additional control for having suffered money burning in a previous round. Although this regressor is mostly 0, if it is correlated with some regressors, it may have influenced our findings. We reestimate all regressions presented in Tables 2 to 10 with a money burning dummy as additional control. We do find that having personally experienced money burning has a negative effect on risk taking that is statistically significant in some regressions (e.g., Kebede and Zizzo 2011). But other results do not change.

the experimental tasks and real world wealth. Participants apply a narrow framing by which they segregate the set of tasks at hand from their wealth outside them. This finding provides support to the intuition of much of the literature and, if anything, is particularly strong evidence of narrow framing given that stakes are large relative to participants' normal income and that, unlike Andersen et al. (2011) who find at least some effect, we find no evidence that risk taking responds to wealth.

2. Asset integration across experimental rounds: We find evidence of integration of winnings within the experiment: participants who won more in earlier rounds increase their risk taking in subsequent rounds. We cannot reject full integration of winnings within the experiment.

3. 'Keep up with the winners': Within each round, participants who receive a small endowment risk a higher share of it. This finding is difficult to account for under a reasonable expected utility model. But it can be explained if the aspiration level of low endowment recipients rises with the knowledge that others received a higher endowment. Under, e.g., loss aversion and a raised reference point due to this social comparison, participants who receive a smaller endowment may then seek to catch up and make up for it by risking relatively more. This hypothesis can also explain why subjects risk more when other participants they can observe have higher past winnings.

4. 'Keep up with the average': We only find limited support for it in our experiment. Participants do take more risk when their past winnings are below that of the average of their peers, but not in a way that suggests they regard the average winnings of others as reference point. Combined with earlier results, this confirms that participants seek to keep up with winners, not just with the average.

5. Learning: We find no evidence that participants revise their priors about the riskiness of their investment decision based on whether they – or their group members – won in the previous round. This finding is not unexpected, given that the stochastic process driving the return on the risky investment is simple and observable by participants.

6. Imitation: We find some evidence of imitation of other participants' risk taking behavior. We can rule out that imitation is driven by the updating of priors because we control for this separately. But evidence of imitation disappears when we control for the observed winnings of others, suggesting that evidence of imitation is spurious. Rather than imitating others, it appears that participants seek to catch up with them.

We believe that two of the above results are of particular interest. First, the evidence suggests that participants seek to keep up with the winners. This may point to issues of salience of the information that participants had (initial income relative to final earnings) when making their decision. This finding highlights the need for further research to ascertain how sensitive the 'keep-up-with-the-winners' effect is to different framing and levels of information about others.

Secondly, we cannot reject full integration of winnings within the experiment but there is no evidence of asset integration beyond the narrow frame of the experiment. This provides support for Cox and Sadiraj's (2006) distinction between total wealth and income and confirms the need to separate the two when estimating risk attitude in applied research. It also raises a question of how to interpret models that link risk attitude with overall wealth and income inequality in a population (e.g., Becker et al., 2005; Hopkins and Kornienko, 2010; Hopkins, 2011). An interpretation of these models is in terms of economic agents being part of a tournament involving their overall wealth with respect to everyone else in the population. The evidence presented here suggests that this interpretation may be unwarranted, as agents may not see themselves as part of a tournament involving their overall integrated wealth, but rather of one or ones involving incomes earned in specific micro decision environments (such as was the one of our experiment). More research is needed to ascertain how strongly our findings would generalize outside our experimental setup.

7. References

Andersen, Steffen, James C. Cox, Glenn W. Harrison, Morten Lau, E. Elisabet Rutström and Vjollca Sadiraj (2011). "Asset Integration and Attitudes to Risk: Theory and Evidence". Department of Economics and Finance, Durham University Working Paper 2011-10.

Andreoni, James, and William T. Harbaugh (2010). "Unexpected Utility: Experimental Tests of Five Key Questions About Preferences over Risk." University of California, San Diego.

Andreoni, James, and Charles Sprenger (2011). "Uncertainty Equivalents: Testing the Limits of the Independence Axiom." National Bureau of Economic Research (NBER).

Battalio, R.C., J.H. Kagel and K. Jiranyakul (1990), "Testing between alternative models of choice under uncertainty: Some initial results", *Journal of Risk and Uncertainty*, 3: 25-50.

Becker, Gary S., Kevin M. Murphy and Ivan Werning (2005) "The Equilibrium Distribution of Income and the Market for Status", *Journal of Political Economy*, 113(2): 282-310.

Binswanger, Hans P. (1981). "Attitudes Toward Risk: Theoretical Implications of an Experiment in Rural India," *The Economic Journal*, 91(364): 867–890.

Case, A.C., and Katz, L.F. (1991). "The company you keep: The effects of family and neighbourhood on disadvantaged youths", NBER working paper 3705.

Clark, A.E. and A.J. Oswald (1998). "Comparison-concave utility and following behaviour in social and economic settings", *Journal of Public Economics,* 70: 133-155.

Croson, Rachel and James Sundali (2005). "The Gambler's Fallacy and the Hot Hand: Empirical Data from Casinos", *Journal of Risk and Uncertainty*, 30(3): 195-209.

Croson, Rachel and Uri Gneezy (2009), "Gender Differences in Preferences", *Journal of Economic Literature*, 47(2): 1–27

Coates, J. M. and J. Herbert (2008). "Endogenous Steroids and Financial Risk Taking on a London Trading Floor", *Proceedings of the National Academy of Sciences*, 105(16): 6167-72.

Cox, James C. and Vjollca Sadiraj (2006). "Small- and Large-Stakes Risk Aversion: Implications of Concavity Calibration for Decision Theory", *Games and Economic Behavior,* 56(1): 45–60.

Genicot, Garance and Debraj Ray (2010). "Aspirations and Inequality", Georgetown University and New York University working paper.

Gertner, Robert (1993). "Game Shows and Economic Behavior: Risk-Taking on 'Card Sharks'", *Quarterly Journal of Economics,* 108(2): 507–521.

Hopkins, Ed (2011). "Inequality and Risk Taking Behaviour". University of Edinburgh working paper.

Hopkins, Ed and Tatiana Kornienko (2010). "Which Inequality? The Inequality of Endowments Versus the Inequality of Rewards", *American Economic Journal: Microeconomics*, 2(3): 106-137.

Kahneman, Daniel and Amos Tversky (1979). "Prospect Theory: An Analysis of Decision under Risk", *Econometrica*, 47(2): 263-291, March

Kawaguchi, D. (2004). "Peer effects on substance use among American teenagers", *Journal of Population Economics* 17: 351-367.

Kebede, B. and D.J. Zizzo (2011). "Envy and Agricultural Innovation: An Experimental Case Study from Ethiopia", Oxford University CSAE Working Paper 2011-06.

Lopes, L.L., and Oden, G.C. (1999). "The role of aspiration level in risky choice: a comparison of cumulative prospect theory and SP/A theory", *Journal of Mathematical Psychology*, 43(2): 286–313.

Lundborg, P. (2006). "Having the wrong friends? Peer effects in adolescent substance use", *Journal of Health Economics,* 25: 214-233.

Powell, L.M., Tauras, J.A., and Ross, H. (2005). "The importance of peer effects, cigarette prices and tobacco control policies for youth smoking behaviour", *Journal of Health Economics,* 24: 950-968.

Rabin, Matthew, and Thaler, Richard (2001). "Risk Aversion", *Journal of Economic Perspectives*, 15(1): 219-232, Winter

Read, D., G. Loewenstein and M. Rabin (1989). "Choice Bracketing", *Journal of Risk and Uncertainty,* 19: 171-197.

Rieger, Marc Oliver (2010). "SP/A and CPT: A reconciliation of two behavioral decision theories", *Economics Letters*, 108: 327–329.

Robson, A. (1992). "Status, the Distribution of Wealth, Private and Social Attitudes to Risk", *Econometrica*, 60: 837-857.

Schechter, Laura (2007). "Risk aversion and expected-utility theory: A calibration exercise," *Journal of Risk & Uncertainty*, 35: 67-76.

Tversky, Amos and Kahneman, Daniel, (1992). "Advances in Prospect Theory: Cumulative Representation of Uncertainty", *Journal of Risk and Uncertainty*, 5(4): 297-323

Zafar, Basit (2011). "An experimental investigation of why individuals conform", *European Economic Review*, 55(6): 774-798.

Table 1: Descriptive statistics

	Rural sites					Addis Ababa University				
	Mean	**Median**	**St.dev.**	**Max**	**Min**	**Mean**	**Median**	**St.dev.**	**Max**	**Min**
Male dummy	0.65					0.91				
Age	46.24	45.00	13.55	85.00	18.00	21.43	21.00	2.39	44.00	18.00
Investment rate (x_{it})	0.29	0.29	0.23	1.00	0.00	0.56	0.47	0.29	1.00	0.00
Lottery winning (in Ethiopian Birr) (W_{it})	5.34	3.00	7.28	45.00	0.00	7.72	0.00	10.37	45.00	0.00
Household assets (in Ethiopian Birr) (A_i)	360.06	232.25	400.68	2754.00	8.00	n.a.	.	.	.	.
Education										
No education	0.50					0.00				
Only literacy	0.08					0.00				
Primary incomplete	0.23					0.00				
Primary complete	0.04					0.00				
Secondary incomplete	0.04					0.00				
Secondary complete	0.08					0.00				
Higher education	0.01					1.00				
Vocational training	0.02					0.00				
Religion										
Ethiopian Orthodox	0.40					0.51				
Muslim	0.16					0.07				
Protestant	0.31					0.34				
Catholic	0.13					0.00				
Other religions	0.00					0.08				

Table 2: Baseline specification (the dependent variable is X_{it}, endowment invested in the lottery)

		Round 1			**Round 2**			**Round 3**	
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Accumulated winnings ($\dot{W}_{it}$)				0.0512***	0.0523***	0.0580***	0.0599***	0.0553***	0.0615***
				(0.0161)	(0.0157)	(0.0139)	(0.0118)	(0.0103)	(0.0117)
Endowment in round (Z_{it})	0.142***	0.142***	0.143***	0.106**	0.105**	0.103***	0.0537	0.0638	0.0426
	(0.0444)	(0.0445)	(0.0399)	(0.0379)	(0.0377)	(0.0321)	(0.0462)	(0.0456)	(0.0334)
Fixed group dummy		-1.750***	-1.537***		-1.280***	-1.021**		-0.842**	-0.679*
		(0.276)	(0.381)		(0.382)	(0.417)		(0.383)	(0.380)
Afternoon session dummy		0.411***	0.497***		0.349**	0.317**		0.936***	0.916***
		(0.139)	(0.171)		(0.139)	(0.150)		(0.198)	(0.208)
Female dummy			-0.473**			-0.386			-0.490
			(0.196)			(0.406)			(0.298)
(Log) Age			-0.367			-1.453***			-1.404**
			(0.530)			(0.482)			(0.503)
Education (no education as omitted category)									
At most primary education			0.599***			1.044**			0.734*
			(0.207)			(0.368)			(0.397)
Above primary education			0.929**			0.289			0.789*
			(0.379)			(0.387)			(0.445)
Religion (Orthodox Christian as omitted category)									
Muslim			-0.604			-1.196***			-0.346
			(0.399)			(0.331)			(0.409)
Protestant			-0.314			-0.0764			0.313
			(0.521)			(0.309)			(0.440)
Catholic			-0.390			-0.0947			-0.0991
			(0.323)			(0.282)			(0.270)
Others			1.241*			0.756			1.554
			(0.596)			(0.684)			(1.109)
Location dummies (Addis Ababa as omitted category)									
Yetmen	-2.775***	-3.650***	-2.622***	-2.101***	-2.742***	-1.691***	-2.281***	-2.696***	-0.813
	(0.388)	(0.126)	(0.375)	(0.313)	(0.282)	(0.467)	(0.352)	(0.444)	(0.735)
Terufe Kechema	-3.808***	-4.683***	-3.289***	-3.015***	-3.653***	-1.922***	-2.900***	-3.333***	-1.425***
	(0.395)	(0.0778)	(0.372)	(0.316)	(0.267)	(0.526)	(0.544)	(0.0768)	(0.425)
Imdibir	-3.458***	-4.333***	-2.925***	-3.328***	-3.967***	-2.463***	-3.669***	-4.097***	-2.020***
	(0.388)	(0.139)	(0.301)	(0.408)	(0.305)	(0.445)	(0.409)	(0.128)	(0.517)
Aze Deboa	-2.742***	-3.617***	-2.230***	-1.697***	-2.336***	-1.051*	-1.732***	-2.157***	-0.638
	(0.550)	(0.240)	(0.633)	(0.350)	(0.270)	(0.508)	(0.516)	(0.0452)	(0.403)
Constant	4.017***	4.686***	4.786**	3.656***	4.119***	8.152***	3.921***	3.887***	7.174***
	(0.447)	(0.512)	(1.919)	(0.488)	(0.477)	(1.707)	(0.392)	(0.399)	(1.856)
Number of observations	360	360	351	360	360	351	360	360	351
R-squared	0.342	0.380	0.412	0.301	0.324	0.388	0.282	0.310	0.360
F-test for asset integration ($\dot{W}_{it} = Z_{it}$)				1.35	1.29	1.33	0.01	0.03	0.21
(P-value)				(0.2600)	(0.2708)	(0.2632)	(0.9100)	(0.8734)	(0.6514)

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 3: With household assets (the dependent variable is X_{it}, endowment invested in the lottery)

VARIABLES	(1) Round 1	(2)	(3)	(4) Round 2	(5)	(6)	(7) Round 3	(8)	(9)
Accumulated winnings ($\tilde{W}_{it}$)				0.0765**	0.0745**	0.0812	0.0919***	0.0815***	0.0852***
				(0.0295)	(0.0298)	(0.0449)	(0.0128)	(0.0138)	(0.0177)
Endowment in round (Z_{it})	0.0598	0.0582	0.0605	0.0775	0.0782	0.0786	-0.0585	-0.0378	-0.0436
	(0.0343)	(0.0344)	(0.0320)	(0.0666)	(0.0664)	(0.0682)	(0.0368)	(0.0360)	(0.0387)
(Log) Assets value (A_i)	0.0181	0.0202	-0.0938	0.227	0.229	0.109	0.217	0.212	0.143
	(0.0837)	(0.0820)	(0.0630)	(0.187)	(0.183)	(0.148)	(0.180)	(0.185)	(0.185)
Afternoon session dummy		0.526***	0.617***		0.397*	0.400		0.818***	0.895***
		(0.126)	(0.157)		(0.202)	(0.238)		(0.106)	(0.125)
Female dummy			-0.283			-0.0294			-0.134
			(0.311)			(0.497)			(0.368)
(Log) Age			0.375			-1.163*			-1.073*
			(0.487)			(0.556)			(0.483)
Education (no education as omitted category)									
At most primary education			0.792**			1.075*			0.809*
			(0.235)			(0.494)			(0.394)
Above primary education			1.307**			0.779*			1.152*
			(0.527)			(0.388)			(0.551)
Religion (Orthodox Christian as omitted category)									
Muslim			-0.395			-1.099***			-0.427
			(0.343)			(0.299)			(0.261)
Protestant			-0.155			-0.253			0.473
			(0.950)			(0.410)			(0.587)
Catholic			-0.441			-0.442			-0.312
			(0.708)			(0.568)			(0.463)
Location dummies (Yetmen as omitted category)									
Terufe Kechema	-0.816**	-0.863***	-0.788**	-0.232	-0.272	0.0507	-0.188	-0.315	-0.587
	(0.236)	(0.146)	(0.281)	(0.151)	(0.331)	(0.390)	(0.368)	(0.226)	(0.401)
Imdibir	-0.503*	-0.508***	-0.306	-0.674*	-0.681*	-0.288	-1.091**	-1.137***	-0.987*
	(0.243)	(0.123)	(0.414)	(0.338)	(0.292)	(0.505)	(0.357)	(0.261)	(0.449)
Aze Deboa	0.147	0.138	0.347	0.881**	0.872**	1.173**	0.495	0.465**	-0.141
	(0.457)	(0.212)	(0.937)	(0.367)	(0.313)	(0.454)	(0.375)	(0.192)	(0.677)
Constant	1.937**	1.717**	0.518	-0.139	-0.300	4.267**	0.705	0.446	4.536
	(0.599)	(0.523)	(2.270)	(1.439)	(1.378)	(1.769)	(1.045)	(1.048)	(2.787)
Number of observations	191	191	188	191	191	188	191	191	188
R-squared	0.070	0.092	0.180	0.189	0.197	0.313	0.167	0.191	0.275

Robust standard errors clustered by session are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Addis Ababa sessions are excluded because asset information is missing.

Table 4: With household expenditures (the dependent variable is X_{it}, endowment invested in the lottery)

	Round 1			Round 2			Round 3		
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Accumulated winnings ($\tilde{W}_{it}$)				0.0836**	0.0817**	0.0852*	0.0886***	0.0781***	0.0827***
				(0.0265)	(0.0269)	(0.0436)	(0.0116)	(0.0130)	(0.0189)
Endowment in round (Z_{it})	0.0595	0.0579	0.0593	0.0726	0.0733	0.0759	-0.0493	-0.0288	-0.0376
	(0.0340)	(0.0341)	(0.0316)	(0.0649)	(0.0648)	(0.0664)	(0.0322)	(0.0319)	(0.0410)
(Log) Household expenditures	-0.0188	-0.0212	-0.0959	0.213	0.210	0.103	0.168	0.157	0.0503
	(0.142)	(0.129)	(0.131)	(0.151)	(0.138)	(0.145)	(0.145)	(0.143)	(0.164)
Afternoon session dummy		0.526***	0.622***		0.389*	0.393		0.818***	0.895***
		(0.128)	(0.167)		(0.187)	(0.228)		(0.129)	(0.121)
Female dummy			-0.285			-0.0311			-0.141
			(0.327)			(0.485)			(0.372)
(Log) Age			0.352			-1.137*			-1.039*
			(0.493)			(0.552)			(0.518)
Education (no education as omitted category)									
At most primary education			0.780**			1.092*			0.852*
			(0.248)			(0.525)			(0.424)
Above primary education			1.268*			0.827*			1.223*
			(0.564)			(0.380)			(0.580)
Religion (Orthodox Christian as omitted category)									
Muslim			-0.358			-1.139***			-0.470
			(0.338)			(0.317)			(0.311)
Protestant			-0.115			-0.295			0.388
			(0.944)			(0.432)			(0.668)
Catholic			-0.433			-0.441			-0.314
			(0.689)			(0.582)			(0.479)
Location dummies (Yetmen as omitted category)									
Terufe Kechema	-0.825***	-0.872***	-0.691*	-0.499**	-0.538*	-0.0495	-0.461	-0.580	-0.703*
	(0.200)	(0.126)	(0.306)	(0.167)	(0.259)	(0.338)	(0.569)	(0.322)	(0.299)
Imdibir	-0.517*	-0.524***	-0.214	-0.899**	-0.906**	-0.393	-1.320***	-1.360***	-1.121**
	(0.231)	(0.0710)	(0.431)	(0.337)	(0.315)	(0.535)	(0.301)	(0.194)	(0.357)
Aze Deboa	0.157	0.149	0.390	0.712	0.704*	1.130**	0.342	0.321	-0.120
	(0.455)	(0.237)	(0.976)	(0.381)	(0.348)	(0.471)	(0.362)	(0.251)	(0.723)
Constant	2.096***	1.895***	0.322	0.599	0.459	4.513**	1.537**	1.282***	5.097*
	(0.543)	(0.459)	(2.127)	(0.808)	(0.782)	(1.874)	(0.505)	(0.323)	(2.380)
Number of observations	191	191	188	191	191	188	191	191	188
R-squared	0.070	0.092	0.179	0.184	0.192	0.312	0.163	0.186	0.273

Robust standard errors clustered by session are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Addis Ababa sessions are excluded because asset information is missing.

Table 5: Learning from own past lottery outcomes (the dependent variable is X_{it}, endowment invested in the lottery)

	Round 2			Round 3		
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Accumulated winnings ($\tilde{W}_{it}$)	0.0535	0.0598	0.0471	0.0689**	0.0719**	0.0656**
	(0.0384)	(0.0368)	(0.0312)	(0.0281)	(0.0264)	(0.0288)
Own past lottery outcomes (s_{it})	-0.0158	-0.0507	0.0744	-0.127	-0.237	-0.0596
	(0.231)	(0.227)	(0.208)	(0.338)	(0.333)	(0.303)
Endowment in round (Z_{it})	0.103	0.0962	0.116**	0.0342	0.0274	0.0335
	(0.0611)	(0.0592)	(0.0490)	(0.0750)	(0.0725)	(0.0650)
Fixed group dummy		-1.282***	-1.020**		-0.844**	-0.679*
		(0.381)	(0.415)		(0.382)	(0.381)
Afternoon session dummy		0.351**	0.314**		0.944***	0.918***
		(0.139)	(0.149)		(0.201)	(0.211)
Female dummy			-0.391			-0.486
			(0.411)			(0.296)
(Log) Age			-1.461***			-1.403**
			(0.474)			(0.505)
Education (no education as omitted category)						
At most primary education			1.045**			0.731*
			(0.367)			(0.403)
Above primary education			0.294			0.782*
			(0.388)			(0.442)
Religion (Orthodox Christian as omitted category)						
Muslim			-1.193***			-0.348
			(0.331)			(0.411)
Protestant			-0.0707			0.310
			(0.310)			(0.437)
Catholic			-0.0767			-0.103
			(0.283)			(0.271)
Others			0.762			1.549
			(0.675)			(1.106)
Location dummies (Addis Ababa as omitted category)						
Yetmen	-2.096***	-2.726***	-1.701***	-2.248***	-2.637***	-0.805
	(0.310)	(0.281)	(0.482)	(0.376)	(0.475)	(0.749)
Terufe Kechema	-3.012***	-3.644***	-1.924***	-2.873***	-3.285***	-1.419***
	(0.306)	(0.270)	(0.530)	(0.542)	(0.0911)	(0.436)
Imdibir	-3.323***	-3.952***	-2.482***	-3.629***	-4.025***	-2.007***
	(0.386)	(0.295)	(0.464)	(0.397)	(0.206)	(0.542)
Aze Deboa	-1.695***	-2.329***	-1.055*	-1.717***	-2.129***	-0.635
	(0.349)	(0.270)	(0.513)	(0.528)	(0.0670)	(0.402)
Constant	3.653***	4.109***	8.182***	3.892***	3.829***	7.164***
	(0.475)	(0.467)	(1.685)	(0.399)	(0.409)	(1.865)
Number of observations	360	360	351	360	360	351
R-squared	0.301	0.324	0.388	0.283	0.310	0.360

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Learning from others (the dependent variable is X_{it}, endowment invested in the lottery)

	Round 2			Round 3		
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Accumulated winnings ($\dot{W}_{it}$)	0.0605	0.0667*	0.0506	0.0680**	0.0715**	0.0653**
	(0.0365)	(0.0340)	(0.0313)	(0.0270)	(0.0259)	(0.0289)
Own past lottery outcomes (s_{it})	-0.0589	-0.0934	0.0527	-0.136	-0.238	-0.0603
	(0.219)	(0.213)	(0.212)	(0.335)	(0.330)	(0.299)
Lottery outcomes of others (s_{-it})	0.281	0.279	0.146	0.465	0.184	0.146
	(0.314)	(0.305)	(0.275)	(0.469)	(0.454)	(0.483)
Endowment in round (Z_{it})	0.0942	0.0875	0.111**	0.0359	0.0283	0.0343
	(0.0608)	(0.0584)	(0.0509)	(0.0726)	(0.0713)	(0.0648)
Fixed group dummy		-1.283***	-1.024**		-0.836**	-0.674*
		(0.387)	(0.422)		(0.382)	(0.385)
Afternoon session dummy		0.348**	0.311*		0.921***	0.900***
		(0.144)	(0.153)		(0.208)	(0.214)
Female dummy			-0.401			-0.491
			(0.412)			(0.293)
(Log) Age			-1.472***			-1.418***
			(0.470)			(0.482)
Education (no education as omitted category)						
At most primary education			1.024**			0.721*
			(0.373)			(0.405)
Above primary education			0.284			0.775*
			(0.392)			(0.436)
Religion (Orthodox Christian as omitted category)						
Muslim			-1.189***			-0.341
			(0.333)			(0.415)
Protestant			-0.0670			0.310
			(0.313)			(0.440)
Catholic			-0.0568			-0.0991
			(0.294)			(0.272)
Others			0.744			1.535
			(0.655)			(1.120)
Location dummies (Addis Ababa as omitted category)						
Yetmen	-2.190***	-2.820***	-1.743***	-2.397***	-2.693***	-0.843
	(0.367)	(0.314)	(0.476)	(0.381)	(0.505)	(0.790)
Terufe Kechema	-2.989***	-3.622***	-1.908***	-2.880***	-3.284***	-1.416***
	(0.294)	(0.274)	(0.536)	(0.538)	(0.0974)	(0.429)
Imdibir	-3.370***	-3.999***	-2.509***	-3.719***	-4.057***	-2.029***
	(0.404)	(0.305)	(0.458)	(0.347)	(0.239)	(0.580)
Aze Deboa	-1.688***	-2.323***	-1.049*	-1.745***	-2.137***	-0.634
	(0.343)	(0.273)	(0.516)	(0.489)	(0.0596)	(0.398)
Constant	3.665***	4.123***	8.238***	3.923***	3.849***	7.237***
	(0.483)	(0.473)	(1.684)	(0.402)	(0.429)	(1.798)
Number of observations	360	360	351	360	360	351
R-squared	0.303	0.326	0.388	0.285	0.311	0.361

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 7: Imitation versus learning from others (the dependent variable is X_{it}, endowment invested in the lottery)

VARIABLES	Round 2 (1)	Round 2 (2)	Round 2 (3)	Round 3 (4)	Round 3 (5)	Round 3 (6)
Accumulated winnings (W_{it})	0.0536***	0.0534***	0.0581***	0.0595***	0.0552***	0.0617***
	(0.0176)	(0.0160)	(0.0153)	(0.00980)	(0.00946)	(0.0115)
Investment of others (X_{-it})	0.300**	0.137	0.238	0.368*	0.0703	0.276
	(0.115)	(0.150)	(0.145)	(0.193)	(0.200)	(0.276)
Lottery outcomes of others (s_{-it})	0.303	0.280	0.175	0.460	0.194	0.187
	(0.284)	(0.296)	(0.262)	(0.441)	(0.454)	(0.493)
Endowment in round (Z_{it})	0.111**	0.106**	0.110***	0.0651	0.0660	0.0510
	(0.0410)	(0.0394)	(0.0350)	(0.0454)	(0.0457)	(0.0346)
Fixed group dummy		-1.041**	-0.600		-0.729*	-0.255
		(0.496)	(0.485)		(0.391)	(0.518)
Afternoon session dummy		0.289	0.227		0.884***	0.793***
		(0.191)	(0.177)		(0.236)	(0.244)
Female dummy			-0.385			-0.494
			(0.425)			(0.295)
(Log) Age			-1.467***			-1.451***
			(0.480)			(0.475)
Education (no education as omitted category)						
At most primary education			1.106**			0.808*
			(0.400)			(0.448)
Above primary education			0.329			0.827*
			(0.393)			(0.444)
Religion (Orthodox Christian as omitted category)						
Muslim			-1.259***			-0.403
			(0.353)			(0.438)
Protestant			-0.144			0.276
			(0.317)			(0.464)
Catholic			-0.113			-0.118
			(0.264)			(0.264)
Others			0.804			1.628
			(0.658)			(1.093)
Location dummies (Addis Ababa as omitted category)						
Yetmen	-1.386***	-2.351***	-0.895	-1.541**	-2.534**	0.0320
	(0.342)	(0.637)	(0.798)	(0.676)	(0.906)	(1.167)
Terufe Kechema	-1.855***	-2.997***	-0.764	-1.638*	-3.038***	-0.204
	(0.447)	(0.805)	(1.035)	(0.915)	(0.829)	(1.351)
Imdibir	-2.356***	-3.435***	-1.448	-2.506***	-3.840***	-0.850
	(0.398)	(0.706)	(0.863)	(0.813)	(0.834)	(1.358)
Aze Deboa	-0.873**	-1.840**	-0.123	-0.938	-1.956***	0.251
	(0.343)	(0.658)	(0.871)	(0.664)	(0.595)	(1.198)
Constant	1.909**	3.243***	6.617***	1.800	3.459**	5.534**
	(0.796)	(1.098)	(1.499)	(1.417)	(1.367)	(2.168)
Number of observations	360	360	351	360	360	351
R-squared	0.317	0.328	0.394	0.293	0.311	0.363

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 8: Social comparisons controlling for learning and imitation (the dependent variable is X_{it}, endowment invested in the lottery)

VARIABLES	(1)	Round 2 (2)	(3)	(4)	Round 3 (5)	(6)
Accumulated winnings ($\dot{W}_{it}$)	0.0727*	0.0734*	0.0561	0.0506***	0.0432***	0.0469**
	(0.0374)	(0.0362)	(0.0346)	(0.0163)	(0.0150)	(0.0208)
Investment of others (X_{-it})	-0.124	-0.292*	-0.165	0.328	0.0883	0.376
	(0.127)	(0.149)	(0.117)	(0.229)	(0.226)	(0.307)
Past lottery winnings of others (G_{-it})	0.269***	0.271**	0.254***	0.0219	-0.0215	-0.0787
	(0.0830)	(0.0974)	(0.0756)	(0.110)	(0.100)	(0.0963)
Own past lottery outcomes (s_{it})	-0.0621	-0.0670	0.0679	0.135	0.179	0.226
	(0.227)	(0.229)	(0.230)	(0.216)	(0.212)	(0.210)
Lottery outcomes of others (s_{-it})	-0.935*	-0.965*	-1.006**	0.325	0.282	0.574
	(0.476)	(0.531)	(0.385)	(0.710)	(0.661)	(0.593)
Endowment in round (Z_{it})	0.0898	0.0845	0.114**	0.0871*	0.0951*	0.0865
	(0.0620)	(0.0601)	(0.0532)	(0.0460)	(0.0461)	(0.0528)
Fixed group dummy		-1.077***	-0.651*		-0.762*	-0.317
		(0.348)	(0.358)		(0.392)	(0.526)
Afternoon session dummy		0.267	0.197		0.913***	0.839***
		(0.160)	(0.154)		(0.232)	(0.244)
Female dummy			-0.295			-0.541
			(0.421)			(0.320)
(Log) Age			-1.426***			-1.482***
			(0.449)			(0.467)
Education (no education as omitted category)						
At most primary education			1.242***			0.781
			(0.395)			(0.453)
Above primary education			0.469			0.833*
			(0.414)			(0.461)
Religion (Orthodox Christian as omitted category)						
Muslim			-1.114***			-0.415
			(0.343)			(0.447)
Protestant			-0.155			0.319
			(0.325)			(0.458)
Catholic			-0.0690			-0.0528
			(0.267)			(0.288)
Others			0.289			1.755
			(0.473)			(1.128)
Location dummies (Addis Ababa as omitted category)						
Yetmen	-1.591***	-2.582***	-1.167*	-1.602**	-2.626***	-0.0114
	(0.320)	(0.423)	(0.640)	(0.680)	(0.896)	(1.165)
Terufe Kechema	-2.227***	-3.400***	-1.289*	-1.697*	-3.113***	-0.196
	(0.418)	(0.523)	(0.741)	(0.904)	(0.819)	(1.393)
Imdibir	-2.426***	-3.532***	-1.662**	-2.571***	-3.960***	-0.971
	(0.361)	(0.496)	(0.673)	(0.823)	(0.853)	(1.396)
Aze Deboa	-1.064***	-2.058***	-0.379	-0.975	-2.000***	0.245
	(0.341)	(0.445)	(0.638)	(0.672)	(0.586)	(1.217)
Constant	2.172***	3.552***	6.709***	1.851	3.534**	5.680**
	(0.757)	(0.845)	(1.436)	(1.400)	(1.352)	(2.200)
Number of observations	360	360	351	360	360	351
R-squared	0.342	0.353	0.415	0.294	0.312	0.367

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 9: Keeping up with the average – quadratic form (the dependent variable is x_{it}, percentage of endowment invested in the lottery)

	Round 2			Round 3		
VARIABLE	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Past winnings (R_{it})	-0.000675	-0.00128	-0.00178	-0.00199	-0.00239	-0.00287
	(0.00200)	(0.00193)	(0.00182)	(0.00312)	(0.00321)	(0.00297)
R_{it}^2	0.000189	0.000221	0.000182	5.43e-05	4.53e-05	4.36e-05
	(0.000155)	(0.000154)	(0.000151)	(6.61e-05)	(6.88e-05)	(6.68e-05)
Endowment (Z_{it})	-0.0218***	-0.0228***	-0.0228***	-0.0305***	-0.0308***	-0.0320***
	(0.00408)	(0.00390)	(0.00439)	(0.00351)	(0.00345)	(0.00371)
Fixed group		-0.146***	-0.123**		-0.103**	-0.0913**
		(0.0489)	(0.0523)		(0.0429)	(0.0410)
Afternoon session		0.0533***	0.0515**		0.0930***	0.0901***
		(0.0181)	(0.0199)		(0.0193)	(0.0193)
Female dummy			-0.0517			-0.0538**
			(0.0374)			(0.0234)
(Log) Age			-0.110**			-0.144**
			(0.0486)			(0.0534)
Education (no education as omitted category)						
At most primary education			0.0973**			0.0698*
			(0.0348)			(0.0402)
Above primary education			0.0198			0.0626
			(0.0310)			(0.0464)
Religion (Orthodox Christian as omitted category)						
Muslim			-0.114***			-0.0366
			(0.0379)			(0.0439)
Protestant			-0.0101			0.0136
			(0.0340)			(0.0405)
Catholic			-0.0182			0.0104
			(0.0386)			(0.0263)
Others			0.0754			0.126
			(0.0682)			(0.0854)
Location dummies (Addis Ababa as omitted category)						
Yetmen	-0.194***	-0.265***	-0.199***	-0.221***	-0.274***	-0.113
	(0.0403)	(0.0381)	(0.0589)	(0.0355)	(0.0440)	(0.0805)
Terufe Kechema	-0.292***	-0.362***	-0.221***	-0.286***	-0.339***	-0.170***
	(0.0309)	(0.0401)	(0.0607)	(0.0579)	(0.0243)	(0.0508)
Imdibir	-0.313***	-0.383***	-0.264***	-0.351***	-0.404***	-0.229***
	(0.0392)	(0.0398)	(0.0503)	(0.0399)	(0.0285)	(0.0653)
Aze Deboa	-0.183***	-0.253***	-0.155***	-0.162***	-0.214***	-0.0674
	(0.0466)	(0.0406)	(0.0513)	(0.0548)	(0.0208)	(0.0496)
Constant	0.763***	0.814***	1.133***	0.878***	0.884***	1.258***
	(0.0603)	(0.0578)	(0.171)	(0.0550)	(0.0483)	(0.194)
Joint test (F- & p-value)	0.05	0.26	0.69	0.37	0.51	0.87
	(0.8212)	(0.6135)	(0.4181)	(0.5519)	(0.4841)	(0.3636)
Obs	360	360	351	360	360	351
R-squared	0.327	0.360	0.425	0.303	0.335	0.393

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 10: Keeping up with the average – linear form (the dependent variable is x_{it}, percentage of endowment invested in the lottery)

	Round 2			**Round 3**		
VAR	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Past winnings (R_{it})	-0.00199	-0.00281**	-0.00303**	-0.00402***	-0.00408***	-0.00450***
	(0.00139)	(0.00121)	(0.00136)	(0.001000)	(0.000961)	(0.00100)
Endowment (Z_{it})	-0.0220***	-0.0230***	-0.0229***	-0.0312***	-0.0313***	-0.0326***
	(0.00406)	(0.00386)	(0.00434)	(0.00328)	(0.00320)	(0.00361)
Fixed group		-0.142***	-0.119**		-0.104**	-0.0917**
		(0.0491)	(0.0520)		(0.0438)	(0.0419)
Afternoon session		0.0534***	0.0518**		0.0933***	0.0906***
		(0.0182)	(0.0198)		(0.0195)	(0.0197)
Female dummy			-0.0511			-0.0546**
			(0.0365)			(0.0228)
(Log) Age			-0.111**			-0.143**
			(0.0492)			(0.0527)
	Education (no education as omitted category)					
At most primary education			0.0989***			0.0700*
			(0.0339)			(0.0397)
Above primary education			0.0220			0.0636
			(0.0301)			(0.0475)
	Religion (Orthodox Christian as omitted category)					
Muslim			-0.113***			-0.0359
			(0.0374)			(0.0433)
Protestant			-0.0120			0.0138
			(0.0333)			(0.0411)
Catholic			-0.0188			0.00997
			(0.0375)			(0.0269)
Others			0.0870			0.124
			(0.0706)			(0.0838)
	Location dummies (Addis Ababa as omitted category)					
Yetmen	-0.204***	-0.274***	-0.204***	-0.229***	-0.281***	-0.119
	(0.0426)	(0.0367)	(0.0579)	(0.0338)	(0.0388)	(0.0774)
Terufe Kechema	-0.306***	-0.376***	-0.231***	-0.294***	-0.346***	-0.175***
	(0.0357)	(0.0385)	(0.0593)	(0.0540)	(0.0188)	(0.0480)
Imdibir	-0.327***	-0.399***	-0.274***	-0.361***	-0.412***	-0.235***
	(0.0444)	(0.0369)	(0.0473)	(0.0391)	(0.0227)	(0.0626)
Aze Deboa	-0.193***	-0.263***	-0.159***	-0.166***	-0.218***	-0.0699
	(0.0477)	(0.0385)	(0.0498)	(0.0534)	(0.0185)	(0.0499)
Constant	0.782***	0.835***	1.150***	0.882***	0.888***	1.258***
	(0.0686)	(0.0603)	(0.176)	(0.0547)	(0.0477)	(0.193)
No. observations	360	360	351	360	360	351
R-squared	0.324	0.356	0.422	0.302	0.335	0.392

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Fig 1. Risk taking and reference point

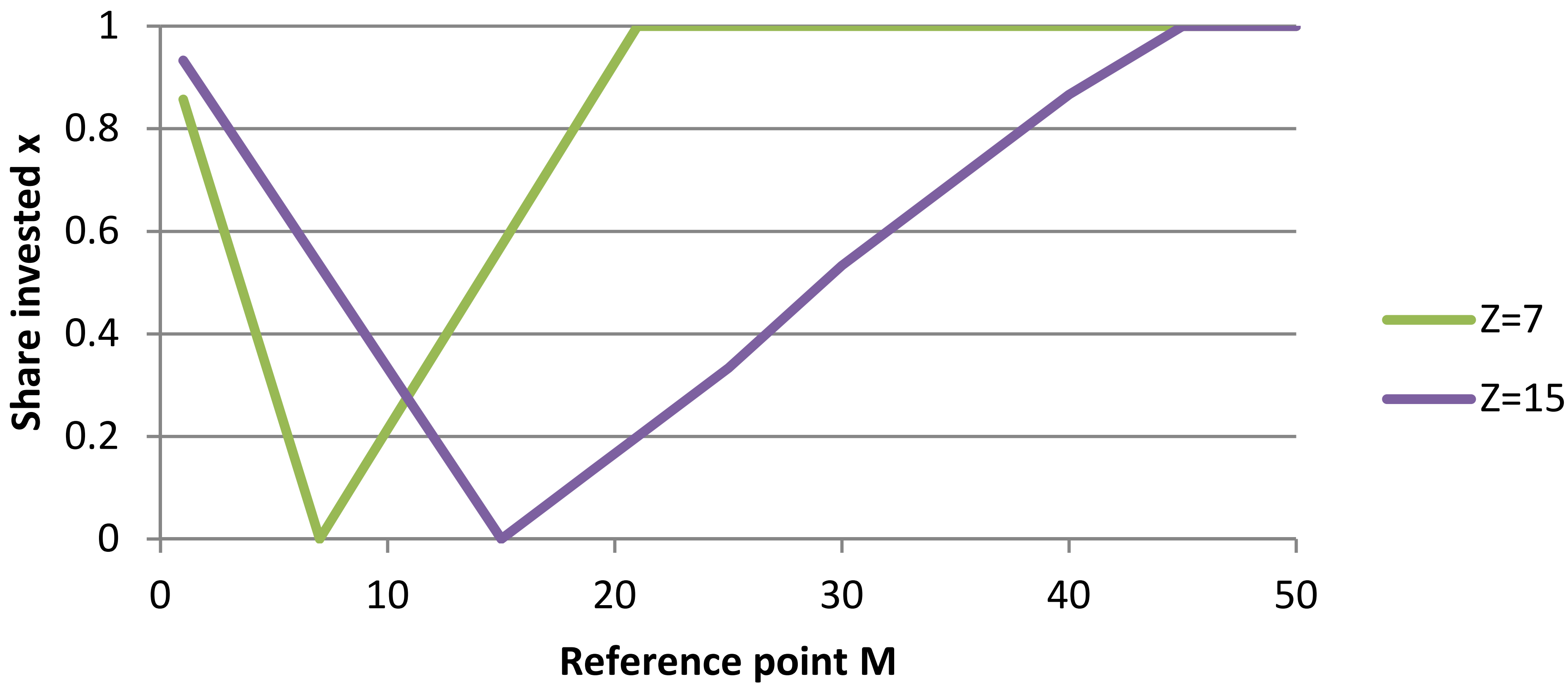


Figure 2. Cumulative distribution of investment rates (x_{it})

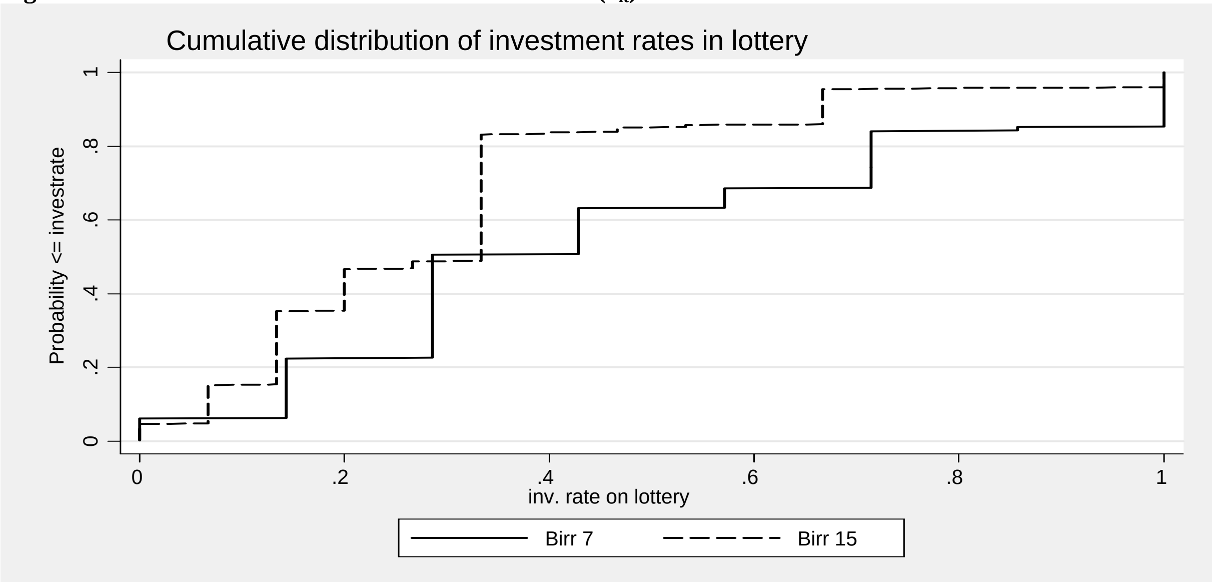
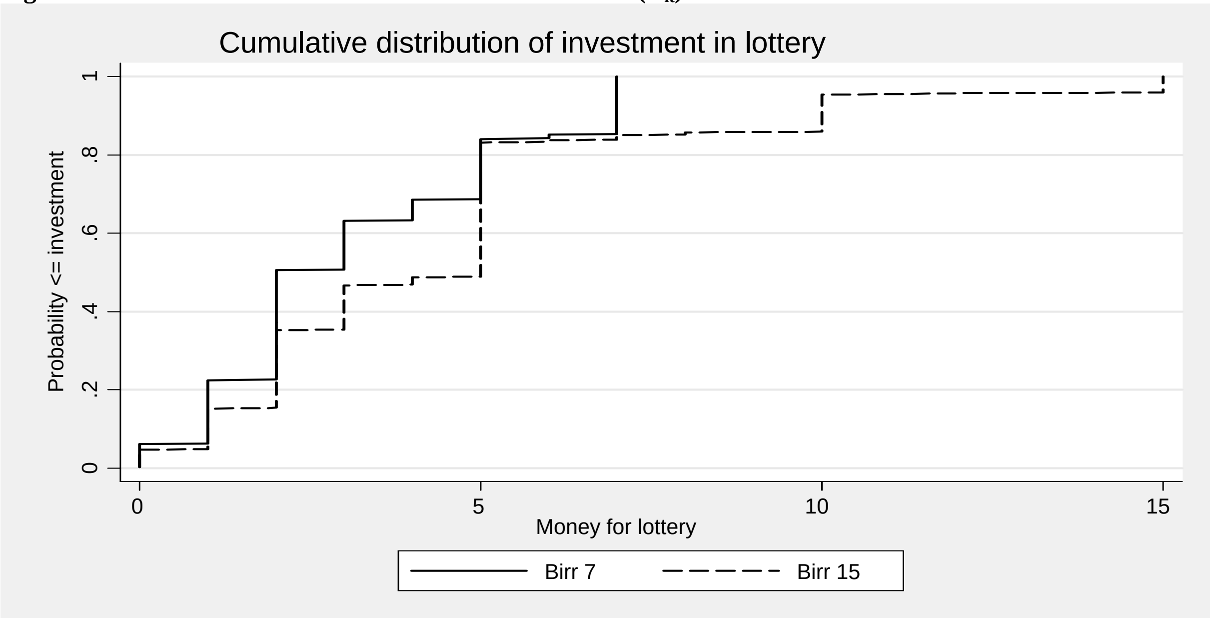


Figure 3. Cumulative distribution of investment amounts (X_{it})



Online Appendix Table 2a: Baseline specification with interval regression (the dependent variable is X_{it}, endowment invested in the lottery)

	Round 1			Round 2			Round 3		
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Accumulated winnings ($\hat{W}_{it}$)				0.0476**	0.0474**	0.0511***	0.0790***	0.0765***	0.0712***
				(0.0200)	(0.0201)	(0.0160)	(0.0107)	(0.0111)	(0.0108)
Endowment in round (Z_{it})	0.130***	0.129***	0.129***	0.137***	0.137***	0.130***	0.0447	0.0495	0.0543
	(0.0303)	(0.0296)	(0.0259)	(0.0290)	(0.0294)	(0.0196)	(0.0374)	(0.0377)	(0.0370)
Fixed group dummy		-1.328***	-1.200***		-0.475*	-0.217		-0.0945	-0.107
		(0.144)	(0.178)		(0.250)	(0.247)		(0.235)	(0.241)
Afternoon session dummy		0.126	0.157		0.270**	0.259**		0.470***	0.558***
		(0.142)	(0.157)		(0.121)	(0.132)		(0.163)	(0.182)
Female dummy			-0.198			-0.267			-0.0735
			(0.205)			(0.266)			(0.249)
(Log) Age			0.165			-0.836***			-0.659
			(0.406)			(0.283)			(0.500)
	Education (no education as omitted category)								
At most primary education			0.265*			0.662***			0.465**
			(0.147)			(0.246)			(0.208)
Above primary education			0.661**			0.269			0.636**
			(0.266)			(0.299)			(0.284)
	Religion (Orthodox Christian as omitted category)								
Muslim			-0.632**			-0.817***			-0.443
			(0.284)			(0.255)			(0.298)
Protestant			-0.416			0.0396			0.424
			(0.352)			(0.291)			(0.396)
Catholic			-0.385			0.134			-0.136
			(0.304)			(0.124)			(0.267)
Others			1.869**			0.768			1.184
			(0.795)			(1.050)			(0.964)
	Location dummies (Addis Ababa as omitted category)								
Yetmen	-1.601***	-2.314***	-1.908***	-1.255***	-1.510***	-0.740***	-0.849***	-0.904**	0.181
	(0.269)	(0.0453)	(0.254)	(0.172)	(0.122)	(0.258)	(0.286)	(0.426)	(0.662)
Terufe Kechema	-2.415***	-3.137***	-2.363***	-2.001***	-2.268***	-1.083**	-1.186***	-1.260***	-0.228
	(0.311)	(0.206)	(0.283)	(0.200)	(0.238)	(0.426)	(0.290)	(0.119)	(0.368)
Imdibir	-2.383***	-3.098***	-2.397***	-2.464***	-2.727***	-1.776***	-2.094***	-2.166***	-1.031***
	(0.269)	(0.0749)	(0.257)	(0.251)	(0.141)	(0.239)	(0.285)	(0.117)	(0.334)
Aze Deboa	-1.599***	-2.310***	-1.479**	-1.098***	-1.365***	-0.569*	-0.521	-0.585***	-0.0203
	(0.458)	(0.325)	(0.640)	(0.242)	(0.127)	(0.310)	(0.322)	(0.149)	(0.412)
Constant	3.118***	3.783***	2.623*	2.613***	2.746***	4.905***	2.016***	1.862***	3.136*
	(0.349)	(0.340)	(1.582)	(0.328)	(0.329)	(0.998)	(0.354)	(0.335)	(1.740)
Number of observations	360	360	351	360	360	351	360	360	351

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Online Appendix Table 5a: Learning from own past lottery outcomes (the dependent variable is X_{it}, endowment invested in the lottery; with actual accumulating winnings)

	Round 2			**Round 3**		
VARIABLES	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Accumulated winnings ($\hat{W}_{it}$)	0.103***	0.0925***	0.0974***	0.0945***	0.0882***	0.0918***
	(0.0270)	(0.0257)	(0.0219)	(0.0237)	(0.0209)	(0.0250)
Own past lottery outcomes (s_{it})	-0.219	-0.172	-0.138	-0.370	-0.367	-0.287
	(0.146)	(0.139)	(0.125)	(0.312)	(0.298)	(0.286)
Endowment in round (Z_{it})	0.0585	0.0685	0.0709*	-0.00805	0.00471	-0.00936
	(0.0418)	(0.0416)	(0.0354)	(0.0452)	(0.0428)	(0.0464)
Fixed group dummy		-1.088***	-0.817**		-0.518	-0.346
		(0.303)	(0.361)		(0.335)	(0.337)
Afternoon session dummy		0.294**	0.249*		0.887***	0.831***
		(0.117)	(0.128)		(0.211)	(0.217)
Female dummy			-0.401			-0.451
			(0.409)			(0.304)
(Log) Age			-1.567***			-1.404**
			(0.467)			(0.517)
	Education (no education as omitted category)					
At most primary education			1.038***			0.638
			(0.342)			(0.428)
Above primary education			0.322			0.849*
			(0.396)			(0.484)
	Religion (Orthodox Christian as omitted category)					
Muslim			-1.181***			-0.209
			(0.406)			(0.422)
Protestant			-0.217			0.211
			(0.308)			(0.401)
Catholic			-0.258			-0.176
			(0.258)			(0.233)
Others			0.849			1.515
			(0.726)			(1.042)
	Location dummies (Addis Ababa as omitted category)					
Yetmen	-2.108***	-2.659***	-1.545***	-2.265***	-2.513***	-0.593
	(0.242)	(0.218)	(0.395)	(0.308)	(0.476)	(0.759)
Terufe Kechema	-3.033***	-3.582***	-1.772***	-2.830***	-3.105***	-1.234**
	(0.276)	(0.194)	(0.481)	(0.585)	(0.199)	(0.525)
Imdibir	-3.200***	-3.765***	-2.110***	-3.525***	-3.796***	-1.694***
	(0.338)	(0.221)	(0.430)	(0.318)	(0.207)	(0.551)
Aze Deboa	-1.737***	-2.282***	-0.795	-1.807***	-2.063***	-0.439
	(0.301)	(0.210)	(0.467)	(0.513)	(0.112)	(0.412)
Constant	3.720***	4.120***	8.507***	4.000***	3.820***	7.113***
	(0.469)	(0.450)	(1.727)	(0.374)	(0.415)	(1.947)
Observations	360	360	351	360	360	351
R-squared	0.328	0.344	0.410	0.314	0.336	0.387

Robust standard errors clustered by session (or fixed player group) are reported in parentheses; *** p<0.01, ** p<0.05, * p<0.1