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Envy and Agricultural Innovation: An Experimental Case Study from Ethiopia

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Abstract

The underlying motivations for envy or related social preferences and their impact on agricultural innovations are examined by combining data from money burning experimental game and household survey from Ethiopia. In the first stage of the money burning experimental game, income inequality is induced by providing different endowments and playing a lottery. In the second, people are allowed to decrease ('burn') other players' money at their own expense. Conditional on individual behaviour, experimentally measured envious preferences from others have a negative effect on real life agricultural innovation.

Keywords: envy, social preferences, money burning games, agricultural innovations, Ethiopia

JEL Classification Codes: C93, D03, O12, O55.

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1. Introduction

This paper uses an experimental set-up to test the proposition that envy or related social preferences can be disruptive to economic development, as innovation may be discouraged out of fear of negative reaction from others (sometimes manifesting itself in the form of the 'evil eye' and similar attitudes). The paper also examines possible underlying motivations for envious preferences. The experiment is run primarily in the field as opposed to the laboratory with a sample of subjects on which information on their real life decisions is available.

Accumulating research in sociology, anthropology, social psychology and economics shows that the welfare of individuals is affected not only by the absolute amount of resources at their command but also by their relative position vis-à-vis others they compare themselves with. These preferences may be the result of envy or related social preferences (such as fairness considerations, reciprocity and inequality aversion) which under some range may operate equivalently in terms of a negative weight placed on the consumption of other agents (e.g., Sobel, 2004). Mui (1995) gives examples from reforming East European countries and China of how envy may have constrained the emergence of entrepreneurs because of the fear of retaliation. If worse off people try to catch up by working harder and channel envy to productive activities (Breitmoser et al., 2009) envy may have a positive effect. But, if envious individuals are willing to devote their resources to decrease the welfare of better off people (Zizzo, 2003; Zizzo and Oswald, 2001) and if potential innovators feel this may happen, it will entail social waste.[2] The effect of envy or related social preferences on innovation may be institutionally and culturally specific (e.g., Grolleau et al., 2009).

This paper is the first study we are aware of which tries to capture the negative effect of envy empirically in a field setting. While anthropologists and sociologists for long emphasized the importance of envy (Bailey, 1971; Schoeck, 1966), more quantitative research on its potential role in developing countries is almost non-existent. This paper attempts to contribute towards filling this gap. In particular, we employ a money burning experimental design (Zizzo and Oswald, 2001; Zizzo, 2003) in Ethiopian rural villages, with additional sessions being ran at Addis Ababa University in an urban setting. Money burning

[2] A different negative effect of envy is captured by Fafchamps and Shilpi (2003) who showed that relative incomes are important and found a rivalry effect so strong that a proportional increase in all incomes *reduces* subjective well-being.

experiments have two parts: in the first, a distribution of resources is induced; in the second, people can use some of their money to decrease others' money ('burn' money). A variant of this experimental setup has stealing allowed in place of money burning (Falk and Fischbacher, 2002) and shows evidence of reciprocal behaviour.

Previous sociological and psychological work in Ethiopia (Hoben, 1973; Korten, 1972; Levine, 1965) indicates a dominant culture characterized by individualism and the pursuit of private rather than communal interests. Levine (1965) argues that there is no sense of community in the dominant Amhara[3] culture. Except in times of crisis, there is hardly any spontaneous cooperation. High degree of suspiciousness and secrecy is pervasive. In addition to weaknesses in horizontal forms of cohesion, the society is characterized by hierarchical forms of interaction. Holding a position of power significantly increases one's status.

Korten (1972) indicates that pressure towards conformity is an important force of social control in Ethiopia. An illustration of the strength of social pressure is the concept of *yilugnta*. "*Yilugnta* is the quality of being very concerned about what other people think and includes a fear of open or implicit public criticism. It requires conforming to what other people expect, even when such action is against one's personal interests or beliefs" (Korten, 1972). Generalizing his findings Korten (1972) concludes: "The characteristics of the zero-sum, nonshared-sum, non-contingent, limited payoff life game are rather clearly portrayed in the data on the Ethiopian society." These studies on Ethiopia imply that envy and similar social preferences probably are very important.

This research first identifies the level of envious preferences by using money burning experimental games and examines the motivations underlying money burning behaviour. Then it goes on looking at the correlation between money burning behaviour and agricultural innovations. We find that the underlying motive for envious behaviour – as captured by money burning in experimental games – is likely reciprocal/retaliatory considerations. While individual money burning behaviour increases the probability of agricultural adoption given individual behaviour envious preferences from others have negative effects on agricultural innovation.

[3] The Amhara are the second largest ethnic group in Ethiopia but due to the political and social history of the country the Amhara culture is dominant.

The rest of the paper is structured as follows. Sections 2 and 3 respectively describe the experimental design and the data collection. While Section 4 discusses the experimental results, Sections 5 and 6 provide general discussion and conclusions respectively.

2. Experimental design

The main objective of this research is to understand the effect of social preferences like envy on investment behaviour in general and agricultural innovations in particular. To induce inequality, players are randomly given high and low amounts of money at the start of the game. The experimental game includes a first stage where participants play a lottery; this mimics investment in innovations as the lottery game is a risky undertaking with a relatively large potential return. The second stage is a money burning stage where players are allowed to decrease the money of others at their own cost.

In a session of a game thirty individuals participate and are randomly given high (Birr[4] 15) and low (Birr 7) amounts of money; we'll call the first high and the second low income players. The players are then divided into five groups with six players in each group, equally divided into high and low income players. Anonymity within each group is strictly maintained, i.e., even though the thirty participants in a session can see each other, with whom they are matched in a group is kept unknown. In the first stage of the game participants can use any amount of their initial endowment to buy a more than actuarially fair lottery with a 50% chance of winning thrice the amount invested.

After the lottery game, players are informed of what amounts of money the other five members of their group have saved and how much they have won (or lost) from the lottery. All six members of a group will then be asked how much of the money of others in their group they would like to 'burn' (decrease). Players have to pay from their own money for burning the money of others; the price of money burning is one tenth of the amount to burn (for example, to decrease another individual's money by Birr 10, Birr 1 has to be paid). The money burning is separately done for saved money and money won from the lottery. This is done to capture potential heterogeneity in money burning behaviour from saved and invested money. For example, if players tend to burn more from lottery earnings than saved money

[4] Birr is the national currency of Ethiopia. At the time the games were played US$1 was around Birr 8.

this can possibly reflect a stronger social preference against earned money – return from a risky undertaking – compared to saved money, money given to the players by others (the researchers).

After eliciting the money burning decisions a random dictator design is used to determine the actual money to be burnt. Hence, even though the amounts all the six players want to burn are recorded only the choice of one will be implemented after a random selection.[5]

The above described game which includes lottery followed by the random dictator money burning stage is repeated three times. At each stage, players are matched with different members in a group; the players are informed about this. At the end of the game, participants will go home with all the money accumulated over the three stages plus a participation fee.

The above version of the money burning game is implemented in four rural villages with 240 people. In addition, the same version is played with sixty university students in Addis Ababa, the capital. A slightly different version of the money burning game is played with two sessions of university students (sixty students in total). In the version played in both rural areas and in Addis Ababa, members of the group change in each stage (random matching); hence, an individual player will be grouped with different people at each stage in the game. In the version played with only sixty of the university students, members of the group stay the same (fixed groups); that is, in all the three stages the same individuals are matched in each group (fixed matching). The main purpose of using the second version is to increase the number of independent observations to improve statistical power.

The next section summarises the data collection process.

3. Data collection

The data for this research are gathered from four villages in Ethiopia which coincide with the lowest subdivision of state administration in rural areas known as Peasant Associations. The four villages were selected to represent as much of the heterogeneity in

[5] Otherwise, if the money burning decisions of all the participants are implemented potentially the money to be burnt can be more than the money given to players.

farming systems and ethnic composition of the country as can be captured by a relatively small sample size. An additional reason for the selection of these villages is the fact that they were covered by previous panel household surveys with rich and detailed household level information that goes back as far as 1994.

The four villages are Imdibir, Aze Deboa, Terufe Kechema and Yetmen. Imdibir is a village located in the Gurage region, southwest of the capital Addis Ababa, adjacent to the local town with the same name. This region is the heartland of a farming system based on *enset*. *Enset* is the false banana tree and it is used as the staple food among many ethnic groups in southern Ethiopia; compared to other crops it's more draught-resistant giving some protection against famine when rains fail. The *enset* farming system is characterized by the use of the hoe in contrast to most cereal producing areas that depend on the ox-plough; perennial (permanent) crops instead of annuals like cereals are dominant. The majority of the people are members of the Gurage, a highly entrepreneurial ethnic group very active in the commercial activities of the country as a whole.

The second research site is Aze Deboa, a village located in the Kembata region, dominated by the Kembata ethnic group, one of the populous ethnic minorities in southern Ethiopia. Even though *enset* is important the dependence of the region on it is not as high as in Imdibir, with cereals and other crops playing a more prominent role. The village is located in a region where long-distance domestic migration is important; during a significant part of the year, male members of the household – mostly household heads – work in far off modern plantations.

The third village is Terufe Kechema, which is located near Shashemene, one of the biggest commercial towns in the south of the country. Here e*nset* is not important and villages surrounding the town of Shashemene benefit from high demand for vegetables. The region, including the research village, is dominated by the Oromo ethnic group, the most populous ethnic group in Ethiopia.

The last village, Yetmen, is the only research site located in the north (northwest of Addis Ababa). Like most agricultural systems in the north, farming in the region is completely dominated by the cultivation of cereals and the ox plough. Yetmen in particular is located in an area well known for the production of *teff*, a type of cereal used only in

Ethiopia. Agricultural production is dominated by *teff* and wheat and because of the very high demand for *teff* the area is characterized by relative prosperity compared to most rural areas of Ethiopia.

As the above brief description of each village indicates the selection of the survey sites maximises the variation in ethnic composition and farming systems. For example, two of the most important ethnic groups in Ethiopia – Oromo and Amhara – are the dominant ethnic groups in the two sites, Terufe Kechema and Yetmen respectively. Similarly, important variations in the settled agricultural systems of the country – the ox-plough and hoe-cultures, the *enset* farming system and systems dependent on annuals like cereals – are all represented. Depending on the type of farming systems and the prosperity of the area the spread of agricultural innovations is also varied. For example, the uptake of fertilisers in these villages is significantly different ranging from a low of 45% in Imdibir to a high of 97% for Yetmen. In Terufe Kechema irrigation is used by some farmers, an innovation that is relatively rare in Ethiopia.

While the heterogeneity in farming systems, agricultural technology and ethnic composition are good reasons for selecting this survey sites, another important reason is that they have already been covered by a comprehensive and long-term panel household survey. All the four villages are part of the Ethiopian Rural Household Survey (ERHS), a panel household survey that covered more than fifteen rural villages in more than six rounds. The households that participated in the experimental games of this research are covered by the ERHS. This provides a very rich data set covering the same households for a period of over fifteen years including data on agricultural innovations. ERHS provides an unusually rich data set that is not available for a small scale research like ours.

Other forms of data than the experimental games were also collected. Pre-game questionnaires were administered before the games collecting background information on participants, agricultural practices and innovations and personalities. Post-game questionnaires were administered focusing on players' experience of the game. Lengths of ring and index fingers were measured to capture digit ratios - the ratio of the length of the index to ring finger. Digit ratios are related to testosterone exposure inside mothers' womb which is expected to influence the character of individuals as the bio-medical literature

indicates. While the above-mentioned research instruments were administered on individuals participating in the money burning experimental games, additional information was also gathered from people that know the villages well through focus group discussions. In all the villages, four focus groups – two with male and two with female members of the community - were organised. The last source of data is sociological survey. Four sociology lecturers from Addis Ababa University were commissioned to write sociological reports for each village using both the grey literature and field visits where key informant interviews, local materials, folklores, anecdotal evidences and similar information were gathered.

The rural fieldwork was conducted in February-March 2009. First individuals covered by the ERHS were traced; due to low mobility/migration in rural Ethiopia finding households that were interviewed in the last round of the rural household survey – in 2004 – was not too difficult. In addition, while 60 individuals were required for the two sessions of the money burning game, the household survey covered more households in each village making it even easier. But some individuals didn't turn up at the time of the game and hence were replaced by others that were not originally covered in the household survey. As a result, 33 out of the 240 rural participants (14%) were not covered by the ERHS.

The games were also played with 120 students of Addis Ababa University in February 2010. The students were mainly at the undergraduate level and from the Education and Business and Economics faculties. While two sessions at Addis Ababa University are identical to the ones played in rural areas, two sessions with fixed groups of players were also conducted, as indicated previously, to increase the number of independent observations and hence improve statistical power.

In most cases in rural areas the games were played in village halls that accommodate the players sitting reasonably far apart; in one village the games were played in two big tents. In Addis Ababa, the students played the games in a very big hall that can accommodate much more people. Research assistants and PhD students were intensively trained and used for running the games. In all cases the games were organised and managed by one of the authors of this paper; the direct involvement of a senior researcher is crucial for data quality.

In all cases, participants came to a designated place (hall) to play the games. This helps to create a more controlled environment for the game compared to playing it sequentially at

different times and places (for example going to homes of participants). But one should also emphasis some fundamental differences between the environment in which the games were played and that of an experimental game laboratory in a Western university. To start with remember that in the rural villages all individuals are drawn from the same village and the participants know that – this will likely increase pro-social behaviour in the experimental games. In addition, even though membership to groups is anonymous – i.e., players don't know with whom they team-up when making money burning decisions – each participant sees the remaining players most or all of whom are likely to be known to him/her; this is different from complete anonymity found in proper experimental labs where individuals interact through computer terminals. Hence, because of these reasons we expect the money burning rates to be biased downwards – in other words, we expect real money burning rates to be higher -.

4. Experimental results

In this section we first provide a general overview of the results. We then go into more depth by employing regression analysis to explain money burning and innovation decisions.

4.1 General overview

A total of 360 subjects participated in the experiments, with 30 subjects per session: 240 in the rural villages (8 sessions with random matching) and 120 in Addis Ababa (2 sessions with random matching, 2 sessions with fixed groups). About two-thirds of the subjects were male in the rural villages (65%), and almost all in Addis Ababa (91%). The average age of university students was 21 versus an average of 46 in the villages. Almost all subjects from the villages were farmers (94%), with percentages no lower than 88% in any individual village; 86% of the subjects from the villages were covered by the Ethiopian Rural Household Survey.

Money burning rates are defined as the amount of money that subjects burn out of the total available to burn. Table 1 shows the money burning rates observed in our experiments.

(*Insert Table 1 about here*.)

Mean money burning rates are about 12% with fixed groups, and about half as much in Addis Ababa with randomly matched groups, with the rural villages situated somewhere in

the middle. There is more money burning with fixed groups than with random matching, and this is confirmed by a Mann Whitney test on the Addis Ababa sample (P = 0.05).[6]

Conversely, there is no significant difference in money burning rates between random groups in Addis Ababa or in rural villages, or, more interestingly, between whether money is burnt out of un-invested earnings or out of lottery earnings – although of course, insofar as lottery earnings lead to greater money in pocket, more money will be burnt on average out of lottery earnings.

RESULT 1. Money burning rates are higher with fixed groups than with randomly matched groups.

(*Insert Table 2 about here*.)

Table 2 provides average values on a number of other variables. Rural subjects are more risk averse than Addis Ababa students, as revealed by their choices to invest less in the lottery (Mann Whitney P < 0.001). Lower digit ratios[7] have been associated with greater competitiveness (e.g., Van den Bergh and Dewitte, 2006; Weis et al., 2007), and on average, as expected, are the same across samples. Questionnaire based measures may be subject to social desirability biases, insofar as subjects may provide responses that they perceive conform to social norms (e.g., Fleming and Zizzo, 2010), and the Marlowe-Crowne 10 items measure is an instrument that aims to identify the sensitivity of subjects to such a social desirability bias (e.g., Marlowe and Crowne, 1960); while there is evidence of social conformism in all samples, there is more from rural villages (Mann Whitney P = 0.001). There is evidence suggesting that this bias works strongly against verbal declarations of perceptions of envy: there is a striking session level Spearman correlation ρ = -0.690 (P = 0.001) between our social desirability measure and the stated degree of envy at the end of the

[6] Here and below in this section, we consider our tests at the level of independent observations: this means the session in the case of random matching sessions, and the group in the case of fixed groups sessions. For example, in this Mann Whitney test, n = 10 for the fixed groups and n = 2 for the random matching sessions. The regression analysis will employ the data more efficiently while controlling for the potential non independence of observations.

[7] Digit ratio refers to the ratio of the length of the index finger to that of the ring finger (also known as 2D:4D) and it has been found to be a good index of exposure to prenatal testosterone. Prenatal testosterone slows the growth rate of the left side of the brain while enhancing growth of the right side (Lutchmaya et al. 2004; Brosnan 2006). This difference in early hormonal exposure is found to affect many aspects of human behavior like athletic prowess (Hönekopp and Schuster 2010), discounting (Millet and Dewitte 2008), career interests (Weis et al. 2007), behavior in ultimatum games (Bergh and Dewitte 2006) and many others including the performance of traders in stock exchanges. Lower digit ratios are associated with higher prenatal exposure of testosterone and this is expected to increase such characteristics as aggressiveness and competitive spirits.

experiment. The social desirability measure proxies for self-declared social niceness and so it is not surprising that it is negatively correlated with self-declared envy. The Big Five is a standard personality questionnaire (e.g., Goldberg, 1993; Ben-Ner et al., 2004; Rammstedt and John, 2007) and shows no statistically significant differences on any personality dimension except for Extraversion,[8] rated higher for the Addis Ababa sample but strongly negatively correlated to the social desirability measure, for which it may work as a reverse proxy (Spearman $\rho = -0.704$, $P < 0.001$).[9] On average and on a scale from one (very well) to four (not at all), the average self-reported measure of understanding of the decision tasks in the experimental games was 2.06 in the rural villages and slightly better among university students (Mann Whitney $P = 0.01$, two tailed); Table 2 shows that among the university students a slightly better understanding is observed in the fixed groups.[10]

RESULT 2. Rural village subjects appear more risk averse and socially conformist. The fixed group environment was slightly clearer to subjects.

There are some interesting correlations relating to money burning from lottery earnings, which emerge already from an analysis that averages out across groups or sessions, as discussed above, in order to obtain independent observations.[11] In the Addis Ababa data, there is a clear negative relationship between lottery earnings and the money burning from lottery earnings (Spearman $\rho = 0.601$, $P = 0.039$), whereas this is not the case in the rural villages.[12] Big Five Extraversion has a quantitatively large but statistically insignificant negative correlation in the subsamples (rural villages: $\rho = -0.524$, $P = 0.183$; Addis Ababa: $\rho = -0.500$, $P = 0.207$). There is some evidence that Big Five Openness predicts greater money burning rate from lottery earnings (Spearman $\rho = 0.415$, $P = 0.07$), a result that, while not reaching statistical significance within the subsample, appears driven by the Addis Ababa

[8] The other four dimensions are Agreeableness, Conscientiousness, Neuroticism and Openness.
[9] There are no statistically significant correlations between the social desirability measure and the other Big Five dimensions.
[10] This is not surprising as the fixed groups environment is arguably a slightly simpler one for subjects to understand.
[11] The same relationships do not apply in relation to money burning from not invested earnings.
[12] Spearman $\rho = -0.524$, $P = 0.183$; this suggests that money burning from lottery earnings was quite independent of the amounts won in rural villages, thus making the burning ratio having (possibly, if not statistically significantly so) a negative relationship.

sessions ($\rho = 0.49$, $P = 0.11$).[13] As noted earlier, our social desirability measure is proxying for social niceness, and as such we would predict that it is negatively correlated with the extent of money burning from lottery earnings. The prediction receives some support in the overall sample ($\rho = - 0.359$, $P = 0.06$), with point correlations being of larger magnitude once we consider subsamples, controlling for the shift in mean money burning rates between the Addis Ababa students and the rural villages subjects ($\rho = -0.427$, $P = 0.08$ for Addis Ababa; $\rho = -0.826$, $P=0.006$ for rural villages).

In the next sub-section factors influencing money burning decisions of players are more carefully examined to understand the underlying social preferences.

4.2 Explaining social preferences: why do people burn others' money?

In this section we employ regression analysis to examine whether money burning rates are correlated to features in the experimental games and to other characteristics of the players. The former include investment rates on lottery (as proxy for risk attitudes), dummies for receiving a high income in the experiment (High Income), the stage of the experiment (Stage 2, Stage 3) and Session 2 (i.e., the second, afternoon session in each village), whether the games are played with fixed or changing group (the Fixed dummy) or with university students or rural inhabitants (the Addis Ababa University AAU dummy). In addition, we include important variables that help us test for some possible underlying motivations for money burning like lagged actual money burning rates and proportion of money from high income players available for money burning. The other variables include age and socio-economic characteristics of participants like education dummies (Primary, Secondary, Higher/vocational) and religion dummies (Muslim, Protestant, Catholic, Other Religions), personality traits as captured by the Big Five (Extraversion, Agreeableness, Conscentiousness, Neuroticism and Openness) and social desirability scale (SDS) values, right and left digit ratios, and emotion values people reported after the games. Additional variables in models 4-7 of Table 3 will be described below.

(*Insert Table 3 about here*.)

[13] For rural villages, $\rho = 0.096$ ($P = 0.82$).

As previously noted, part of the money to be burnt is from money set aside (not invested on lottery) and part of it is from lottery earnings. To capture possible heterogeneity, the two burning rates are separately used as regressands instead of using an overall money burning rate. However, Seemingly Unrelated Regressions (SUR) is used since the error terms from these regressions are not independent as confirmed by the Breusch-Pagan tests.

In all localities, two sessions of the money burning game were conducted, one in the morning and one in the afternoon. All the coefficients on Session 2 are not significant, indicating that – as expected – the behaviour of players in the morning and afternoon sessions is not different. In the fieldwork, the utmost care was done to avoid communication between players in the morning and afternoon, and the regression results confirm that was effective avoiding possible contamination due to communication between people in the two sessions.

In almost all the specifications, money burning rates consistently and significantly decrease across stages; this is true both for money burning from non-investment as well as lottery earnings ($p < 0.01$ or 0.05). This is likely due to the low level of money burning rates in stage 1; even those that burn money in the first stage decrease their burning after seeing the low level of money burning.

In five out of the seven cases there is weak evidence (mostly at $p < 0.1$) of 'high income' players burning proportionally more from non-invested money; but money burning from lottery earnings is not significant. The 'income' effect on money burning behaviour is generally rather weak.

There is a possible gender effect with respect to money burning rates from non-invested money ($p < 0.05$ except in model 7), while all the coefficients on age and education in all the models are not statistically significant.[14]

Almost all coefficients on religion – except those for 'other religions' – are not statistically significant. Interestingly, for the 'other religions', while almost all the coefficients in the non-invested regressions are not significant, those in relation to lottery earnings are significant and negative (at $p < 0.05$ level). Orthodox Christian, Islam, Protestant

[14] The lack of correlation with education probably undermines a view that modern education changes the attitude of people towards a more growth oriented paradigm; if this view was right at least in our context, we would have found negative coefficients with higher levels of education as money burning is destructive from the society's point of view.

and Catholic religions are established formal churches (Orthodox Christianity is the reference omitted religion). The 'other religions' are mainly minority and traditional ethnic based religions that are practiced at local levels. Subjects with these 'other' religions burn less money from lottery earnings than other religions; but generally they are not different in their money burning behaviour with respect to lottery earnings.

In all the models money burning rates are not significantly correlated to investment rates in the games (the proportion of money players used for lottery). This indicates that risk taking and money burning behaviours as captured in the experimental games are not correlated.

RESULT 3. Money burning is not correlated with education, risk taking and age; men burn less of un-invested earnings; less burning out of lottery earnings occurs by subjects with minority and traditional ethnic religions.

We next check whether there is a relationship between others' income and money burning in our data, as for example predicted by an inequality aversion based explanation.[15] Note that people make two types of money burning decisions in the games; they are separately asked how much to burn from non-invested money and lottery earnings. Also note that there are two relevant income distributions – initial and final – that can possibly affect players' decisions. First, at the beginning of the game, half of the players are given higher amounts of money than the other half. We calculated the share of high income players from the money available for burning. The variables '% high income' and '% high income 2' in Table 3 in the part titled 'Inequality aversion?' represent the share of initial high income players from non-invested money and lottery earnings respectively. But also note that after playing lottery the amounts of money players have had changed during the game; hence, the income inequality at the end may not tally with initial income distribution. For example, initial high income players may have lost after playing a lottery to become low income players. To control for this, the sum of money available for burning are included in the regression – if final income distribution matters and players are inequality averse they will

[15] For a simple review of the inequality aversion model, see Camerer (2003).

burn more of the money those that have more money at the end. These two variables are named 'Sum not invested' and 'Sum lottery wins' in the 'inequality aversion?' part of Table 3. Almost all the coefficients are not statistically significant (only one coefficient is significant at only $p < 0.1$ level). Hence, our data does not provide support that underlying motivation for money burning is inequality aversion.[16] Note that this would not prevent fear of envy from being a rationally held expectation: if subjects are richer, there is more that can be burnt of them as a result, even though the proportion of their income that gets burnt does not increase.

Another possible underlying motivation for money burning behaviour is retaliation and/or reciprocity (e.g., Fehr and Gaechter, 2000) either directly or as a way of making the expression of envy legitimate. People may burn other people's money because they expect other people to be burning theirs. To test whether retaliatory/reciprocal motives are important in money burning behaviour, we included lagged actual money burnings in our regressions. Remember the money burning games have three stages and from the money burning decisions of all players in a group only the decision of one is implemented (random dictator design). The lagged actual money burnings are those in the previous stage. The lagged money burnings from non-invested earnings and lottery earnings are entered as separate variables (Lag AMBNI and Lag AMBLW, respectively). There is some evidence that retaliatory/reciprocal considerations are possible motivation for money burning behaviour especially with respect to lottery earnings ($p < 0.1$ for Lag AMBNI and 0.05 for Lag AMBLW). This may appear surprising since, as demonstrated in further regressions where we interacted these variables with whether subjects belonged to fixed group, it can be shown that the effect is not restricted to fixed groups. This does not mean that being in a fixed group does not increase money burning: the consistent positive coefficients on the fixed groups dummy is clear evidence that greater money burning did occur in fixed groups, and conforms to Result 1 above. That being said, even when subjects are matched with a different group, there are spillover effects from having being treated badly by third parties on what one does in terms of money burning: this could operate as a revision of expectations about future

[16] We did also experiment by dropping and including the two sets of variables – the percentage of high income and sum of money – to see if our results are influenced by multicolinearity; the results do not change.

burning or as a form of indirect reciprocity or a rationalization of envious behaviour based on indirect reciprocity. It is also interesting to find that there is no significant effect with respect to actual money burning from non-invested money. The results suggest that people are more sensitive to money burning from money they have 'earned' (by playing lottery) than simply received.

RESULT 4. Money burning is not only greater as a result of repeated interaction but also, when play is one shot and with respect to 'earned' lottery earnings, as the outcome of indirect reciprocity or a justification of envious behaviour based on indirect reciprocity.

We next consider the variables related to social desirability, the Big Five personality scale and digit ratios. In section 4.1 we noted that Big Five Extraversion may work as an inverse proxy for social desirability. The regression analysis includes both Big Five and the Marlowe and Crowne (1960) social desirability scale in models 4, 5, 6 and 7. As in the earlier analysis, Extraversion in most cases is negatively correlated to money burning rates; the effect is stronger for money burning rates from un-invested earnings ($p < 0.01$ or 0.05) compared to that from lottery earnings ($p < 0.1$ or not significant). The social desirability measure is statistically significant in models 4, 5 and 6, and higher social desirability increases money burning from un-invested earnings ($p < 0.05$ or 0.01).

Our regression analysis confirms the bivariate results from the previous section insofar as they do not show any effect for Conscientiousness and Neuroticism. Agreeableness and Openness have interesting differing effects; while Agreeableness mainly reduces money burning from un-invested earnings, Openness' main effect is to reduce money burning from lottery earnings ($p < 0.01$ or 0.05), which differs from the direction observed in the bivariate analysis. Our results seem to suggest that more open people are reluctant to burn the money of others which is earned through an effort.

RESULT 5. Subjects that score low in Agreeableness burn more from un-invested earnings, whereas subjects that score low in Openness burn more from 'earned' lottery earnings.

To examine if underlying physiological features of individuals affect their money burning behaviour, digit ratios are added to models 5, 6 and 7. It will be recalled that lower digit ratios are associated with higher prenatal exposure of testosterone and this is expected to increase such characters as aggressiveness and competitive spirits. In our case, while right hand digit ratios are significantly and (as expected) negatively correlated with money burning rates, particularly in relation to money burning from lottery earnings ($p < 0.01$),[17] left hand ratios are not. The highly significant and negative correlation between right hand ratios and money burning rates of both types strongly suggests that the underlying biophysical traits of individuals (such as prenatal hormonal exposure) likely affect their social preferences. The fact that only the right hand digit ratios are significant also falls into the findings of the wider literature where for some activities only the ratio of one hand has good predictive power (for example, see Lutchmaya et al., 2004).

RESULT 6. Lower right hand digit ratios predict greater money burning, particularly in relation to lottery earnings.

The final set of variables examines if emotions are systematically correlated to the money burning behaviour. At the end of the experimental games, players reported what emotions they felt when playing the games. Players who felt 'fear of envy' proportionally burned more ($p < 0.01$ and 0.05 in model 6), though the effect is not much robust to introducing the Lag AMBNI and Lag AMBLW variables ($p < 0.1$ in relation to un-invested earnings only in model 7). Taken at its face value, this result implies that one of the motivations for burning others' money is the fear that others may burn one's money. This reinforces the previous finding that retaliatory motives seem to play a more important role. There is also some rather weak (but interesting) evidence that those people who felt 'ashamed' and 'irritated' burn less. Almost all the coefficients on 'envy' are not significant.

[17] $P< 0.1$ in relation to un-invested earnings.

RESULT 7. There is some evidence that people who reported that they felt 'fear of envy' while playing the experimental games may proportionally burn more money.

To summarize, while some socio-economic characteristics like religion play a relatively weak role in determining money burning, others like age and education are not important correlates. There is some evidence that people are justifying burning others' money based on others' expected burning, though not necessarily those they have been matched with already. Personality traits and digit ratios are generally significantly correlated to money burning behaviour underlining the importance of controlling for these factors when doing research on individual behaviour. The 'fear of envy' also seems to be an important motivation for burning more money further reinforcing the implication that retaliatory motives are more important.

The next section will examine the link between innovations and envy as captured by the money burning behaviour in the experimental games.

4.3 Innovation and envy

One of the key objectives of our experiment is to understand the effect of social preferences such as envy on innovations in general and agricultural innovations in particular. We shall examine these issues by combining our experimental data with household information collected by the Ethiopian Rural Household Survey (ERHS). Note that this section uses data only from rural participants because of the focus on agricultural innovations.

Envy, proxied by money burning behaviour in the experimental games, is expected to influence agricultural innovations through three different channels. First, individual money burning behaviour likely captures relevant individual characteristics correlated to innovation behaviour. For example, people willing to burn others' money are probably more aggressive and competitive and hence are expected to be more innovative. Second, the money burning behaviour of others (*social money burning)* is also expected to affect individual innovation behaviour; a farmer in a community with high social money burning will be discouraged to invest as some of the returns from investment will be destroyed by others. Third, the interaction between individual and social money burning is also an important factor. Even

though a positive correlation between individual money burning behaviour and innovation is expected, if everybody in the community behaves similarly the effect may be different depending on feedback effects (externality); high individual and social money burning may have a negative effect on innovation. Given other determinants of innovation, the innovation function can be presented as follows:

$$I_{ij} = f(MBR_{ij}^{i},\ MBR_{ij}^{s},\ MBR_{ij}^{i} * MBR_{ij}^{s} | IN_{ij},\ HH_{ij},\ F_{j}) \qquad \ldots (1)$$

In equation (1) the subscripts *i* and *j* index households and villages respectively; in our sample the households are from four villages hence *j* runs from 1 to 4. I_{ij} stands for innovations implemented by the household, MBR_{ij}^{i} and MBR_{ij}^{s} stand for individual and social money burning rates and IN_{ij} and HH_{ij} represent individual and household characteristics that affect innovation and village level fixed effects are captured by F_j. The interaction between individual and social money burning is $MBR_{ij}^{i} * MBR_{ij}^{s}$.

To measure the overall adoption rates of households (I_{ij} in equation (1)) a simple innovation index is computed using the ERHS data. This index captures twelve agricultural innovations introduced at different rounds of the survey; farmers were asked whether they grow new crops like coffee and *chat*,[18] whether they have improved livestock, use modern agricultural inputs, farm other new crops, use irrigation, water holes, improved seeds and/or fertilizer, whether they were selected as model farmers, participated in soil conservation or rain harvesting programs. If their responses are affirmative for each of these questions a score of 1 is given; if not, a score of 0. The simple sum of these scores provides an index of innovation. For example, a farm household that adopted all the twelve innovations will have a score of twelve and a household that has not adopted any will have a score of zero.

(*Insert Table 4 about here*.)

A tabulation of the innovation index is given in Table 4. While the mean of the index is 3.75 the median is four with a maximum of eight and minimum of one; in other words, households on the average have adopted around four of the innovations and at least one of the innovations have been adopted by all households with the most innovative households implementing eight.

[18] *Chat* is a mildly intoxicating plant that is consumed widely both in Ethiopia as well as neighboring countries. *Chat* is an important source of income for the farmers as well as a major foreign exchange earner for the country.

Community level envious preferences (MBR_{ij}^{s} in equation (1)) are proxied by *social money burning rates* that are computed in the following way using the money burning rates in the experimental games. For each individual the average money burning rate of all *other* individuals (i.e., excluding the individual's money burning rate) in the village is computed. Social effects should reflect what each individual expects on the average from the rest of the people in the village.

To estimate equation (1) the innovation index is regressed on individual and social money burning rates and the interaction between the two in addition to other controls. Note that the social money burning rates are computed by averaging the money burning rates of all other members of the same village and hence it is strongly correlated to village level fixed effects (F_j); hence, the direct effect of social money burning will be absorbed in the village fixed effects and there is no statistical variation to disentangle it from the other fixed effects since there are only four villages. Hence, the regression estimated has the following modified form with the direct effect of social money burning (the coefficient on MBR_{ij}^{s}) being absorbed in the village fixed effects.

$$I_{ij} = f(MBR_{ij}^{i},\ MBR_{ij}^{i} * MBR_{ij}^{s} | IN_{ij},\ HH_{ij},\ F_j) \qquad \ldots (2)$$

The above regression is estimated using OLS, negative binomial and robust regressions to examine the robustness of the results to different specifications. The negative binomial model is used because the innovation index is count data. Robust regression is to examine the robustness of results to significant outliers; the robust regression method uses Cook's distance to eliminate significant outliers and employs an iteration procedure as suggested by Li (1985). In addition to using different estimation specifications, the same models are also estimated by including different variables to see if results are robust to inclusion and exclusion of variables.

(*Insert Table 5 about here*.)

As indicated previously, in the experimental games players were allowed to burn money from non-invested earnings and lottery earnings separately. Interestingly, while the coefficients on money burning rates from non-invested earnings are consistently not significant in all specifications, those from lottery earnings are significant and positive. As argued in a previous paragraph, the money burning behaviour of participants especially from

that of lottery earnings seems to capture characteristics of individuals (e.g., competitiveness, aggression, etc.) that positively impact on agricultural innovations.

RESULT 8. Higher individual money burning rates from lottery earnings are positively correlated to agricultural innovations measured by an index based on the Ethiopian Rural Household Survey.

In addition to the individual money burning rates, the interaction terms between individual and social money burning rates are the other variables of main interest. While the coefficients on the money burning from non-investment are all insignificant, those on lottery earnings are all negative and significant when all covariates are controlled for ($p < 0.01$ or 0.05 in models 3). This implies that there is an interesting negative feedback (externality) between individual and social money burning. Even though higher money burning behaviour from lottery earnings is correlated positively to agricultural innovations, the same behaviour negatively affects innovations especially if the social money burning is high in the community. For a given individual money burning rate from lottery earnings, the negative effect becomes higher the higher the social money burning rate. To illustrate this, we use the coefficients from the OLS regression of model 3 in Table 5 and graph the partial effects of individual money burning rates and the interaction between individual and social money burning rates from lottery earnings (see Figure 1). In the OLS model 3, while the coefficient on individual money burning rates from lottery winning is 44.438, the corresponding coefficient on the interactive term is -527.769. Hence, the partial effect of the individual and interactive money burning rates on the innovation index I_{ij} is equal to $44.438*MBR_{ij}^{i}$ - $527.769*MBR_{ij}^{i}*MBR_{ij}^{s}$. Each line in Figure 1 represents the effects of different levels of social money burning rates (ranging from 0% to 30%) on the innovation index at a given level of individual money burning rates (for 5%, 10%, 15%, 20%, 25% and 30%). As can be seen from Figure 1, for given individual money burning rates the partial effects decrease ultimately falling below zero with higher social money burning rates. The figure also clearly shows, that the higher the individual money burning rate the steeper the slope of the curve implying the negative effect of social money burning rates on innovation is larger the higher

the individual money burning rates. Note that the lines intersect the zero horizontal line around 8.4% social money burning rates. This implies that for individuals that face a social money burning rate from lottery earnings that is less than 8.4% their individual money burning behaviour is associated with higher innovation index; but individuals facing social money burning rates higher than 8.4% are associated with lower innovation index. This negative impact is higher for those with higher individual money burning behaviour.

(Insert Figure 1 about here.)

RESULT 9. The interaction between individual and social money burning from lottery earnings is negative and significant implying a negative feedback (externality) that individuals with high money burning rates in a community with high money burning tend to innovate less.

Even though, as indicated previously, the direct effect of social money burning on innovations cannot be separated from the village fixed effects, it's expected to be negative; this is because the social money burning rates capture the willingness of others to destroy resources which most likely creates a disincentive to innovate. In fact, when estimating the regressions reported in Table 5 without village dummy variables but with social money burning rates they are consistently negative and significant.

Let us now look at the other variables included in the innovation regressions. Almost all the individual and household variables reported in the second part of Table 5 are not significant. Land cultivated by the household is included to control for income/wealth effects. Income and consumption expenditures are not used because of endogeneity concerns, as unobservables are likely to be correlated with them. In Ethiopia land is owned by the state and allocated on a usufruct basis to farmer households and hence we don't expect reverse causality from innovations to land size as we do in the case of household income/expenditure. There is weak evidence that males and married people innovate more compared to females and unmarried people. Almost all the coefficients on education except on higher education are not significant; the coefficients on higher education, contrary to expectations, are negative. But this likely reflects the fact that those with higher education mainly work in non-

agricultural activities; since we are considering agricultural innovations the negative coefficients are not surprising. There is some rather weak evidence that Catholics and Protestants innovate less than Orthodox Christians (the omitted religion); Muslims innovate as much as Orthodox Christians.

The second set of regressions includes Big 5 personality dimensions, the Social Desirability Scales (SDS) and digit ratio. Except neuroticism and openness in single cases, all other personality and SDS coefficients are not significant. There is some weak evidence that right-hand digit ratios are negatively related to innovation. The stronger correlation we observed between personality dimensions and digit ratios with money burning behaviour (in Table 3) and the lack of correlation with the innovation index imply that these factors likely influence innovations not directly but through influencing intermediary characteristics like money burning behaviour of individuals.

The final set of regressions adds emotion and subjective well-being. In a post-game questionnaire players were asked which emotion they felt when playing the money burning game. These are included in the regressions because they may be reflecting some underlying states of the individuals that can affect innovation behaviour. In addition to the emotion variables, a variable reflecting the subjective well-being of individuals is also included. In one of the rounds of the ERHS respondents were asked to rank their subjective well-being using a hypothetical ladder with ten rungs, the highest (tenth) rung representing the best possible and the lowest the worst possible life. It's interesting that there is a significant and positive correlation between subjective well-being and innovation. Intriguingly, those players that reported they felt joy while playing the experimental game have higher innovation index compared to those that reported that they didn't feel joy at all. Even though the coefficient on 'happiness' is significant and *negative* in two cases, it is likely driven by outliers as it is no more significant when robust regression is used. Overall, individuals with the highest subjective well being seem to innovate more. These results are likely capturing some underlying individual characteristics relevant for innovation behaviour but not captured by the personality questionnaire.

Finally, the highly significant dummy variables indicate that village level fixed effects, including social money burning rates, are very important. The magnitudes of the coefficients

indicate that in terms of the innovation index while the village of Aze Deboa is the most innovative, Imdibir is the least innovative.

So far, an index that captures the overall number of innovations by households is used as a measure of agricultural innovation. An alternative is to look at individual innovations. In a pre-game questionnaire, participants of the experimental games were asked if they use fertiliser and improved seeds and harvest rain water. The yes/no responses on these innovations are used in probits to examine the role of money burning behaviour (see Table 6 for results). Advantages of this method are the larger sample, as we need not rely on experimental subjects having been part of the EHRS, and the closer connection between experimental responses and real world innovation decisions, both temporally and in terms of identity of the respondents.[19]

(*Insert Table 6 about here*.)

As in the case of the innovation index, the individual money burning rates from lottery earnings for fertiliser and improved seeds are significant and positive ($p < 0.001$); in addition, the interaction between individual and social money burning rates from lottery earnings are negative for these two innovations ($p < 0.1$ for fertilisers; $p < 0.05$ for improved seed). These results reinforce the results from the regressions on the innovation index. Intriguingly both coefficients for rain harvesting are not significant but that for money burning from non–investment and its interaction with social money burning rates are significant. It's difficult to know why rain harvesting is correlated to money burning behaviour in a different way compared to fertiliser and improved seeds use. But it's apparent that it is a very different type of investment compared to the other two. First, rain harvesting requires building relatively permanent structures like ponds; the other two don't. Second, these structures are built on land allocated by the state; hence, whether the household has an allocated land that is suitable for this investment will definitely affect investment. In contrast, fertiliser and improved seeds are more 'scale neutral'. Third, there is a lot of technical, material and other forms of support from the government to encourage rain harvesting. In contrast, the support in terms of

[19] While we aimed to take responses from EHRS sampled households, we cannot necessarily guarantee that EHRS data was collected from precisely the same individuals who later participated to our experiment. Real world innovation information collected in the experiment obviously solves this potential source of noise.

subsidies for fertilisers and improved seeds is increasingly diminishing or non-existent. These differences in the nature of the innovations may be the underlying causes for the differences.

RESULT 10. While individual money burning rates are significantly and positively correlated to the adoption of fertiliser and improved seeds, interactions between individual and social money burning rates from lottery earnings are negatively correlated. Rain harvesting exhibits a different pattern.

Investment rates on the lottery in the experimental games are highly significant and positively correlated to adoption of fertiliser and improved seeds; but the coefficient on rain harvesting is significant but *negative* ($p < 0.01$). These results also underscore the significant difference between rain harvesting and the other two innovations. This difference more or less seems to persist with the coefficients on other control variables. Males and older people have a higher chance of adopting fertiliser and improved seeds ($p < 0.01$); but both variables are not significant for rain harvesting. Interestingly, the adoption of fertiliser and improved seeds is negatively related to land size ($p < 0.05$); it seems that farmers compensate for the small size of their plots by using more fertiliser. Primary and secondary education is significant only for fertiliser adoption ($p < 0.1$ and 0.05 respectively). As in the case with innovation index, Catholics have a lesser probability of adopting rain harvesting and improved seeds ($p < 0.01$). There is some weak evidence that some aspects of the Big-5 personality dimensions like conscientiousness and neuroticism are correlated to some of the innovations. The Social Desirability Scale is positively related to the adoption of improved seeds ($p < 0.001$). The negative correlation between right-hand digit ratios and innovation survives only for improved seeds ($p < 0.01$). Even though many emotion variables are significant, a clear pattern does not emerge.

The next section provides general discussion relating the results presented so far with the additional information collected through sociological surveys and focus group discussions in particular and with the sociological literature on Ethiopia in general.

5. Discussion

"May you have wealth and envious people around you"
(a proverb from Terufe Kechema, one of the study villages; Esayas, 2009)

Let us first recapitulate the main results from the quantitative analysis so far. Even though some socio-economic characteristics like education and age of players are not significantly related to money burning behaviour, there is some evidence that gender and religious beliefs (especially minority and traditional religions) are. The evidence also implies that more than inequality aversion the main underlying motivation behind money burning behaviour is likely reciprocal and/or retaliatory considerations. Some of the Big-5 personality dimensions like Extraversion, Agreeableness and Openness are negatively correlated to money burning behaviour. The underlying physiological characteristic of individuals related to prenatal hormonal exposure as captured by digit ratios is also significantly correlated to money burning behaviour. While individual envy as captured by individual money burning rates from lottery earnings are positively correlated to agricultural innovations they have a negative feedback through their social effect; for given individual money burning behaviour higher social money burning decreases innovation.

As indicated in the data collection section, in addition to the experimental games, we compiled sociological reports prepared by university sociology lecturers and conducted eight focus group discussions with one male and one female group in each village. Let us summarise and discuss the more relevant findings from these qualitative data sources.

The qualitative data strongly suggest that envy and similar social preferences are widespread in the study villages. As the proverb from one of the villages at the beginning of this section indicates, envy is considered by most as an automatic consequence of success and achievement ('if you become rich people will envy you'). The sociological reports are full of stories that provide anecdotal evidence to the destructive nature of these social preferences even among close family members.[20] The negative effect on agricultural innovations is clearly highlighted by one of the farmers:

[20] In Imdibir, one of the study villages, a man is reported to have set fire on his brother's farm when his brother started cultivating a more profitable cereal.

> "Using better technology might be good in terms of increasing yields. But it also increases the number of enemies one might have. You will be targeted by enemies including wild animals and those who possess the power of evil eye; they will affect your cattle's fertility as well as the fertility of the soil permanently." (Desalegn, 2009)

The reference to the evil eye in the above quotation touches on an important aspect that reflects the mentality widespread in Ethiopia in general and in the study villages and has an implication on social preferences. The belief in witchcraft and the evil eye is a universal pan-Ethiopian characteristic (Levine, 1974) and successful people are routinely suspected of witchcraft and witchcraft in turn is also believed to be used against successful people. Even though people from some groups are particularly suspected of having the power of witchcraft and the evil eye, almost no one is beyond suspicion. A generalised atmosphere of fear and suspicion of witchcraft and the evil eye is usually associated with envy (Schoeck, 1966).

The nature of social differentiation in the study villages is expected to influence social preferences. In most rural localities, even though many ethnic groups live together one ethnic group is usually dominant; for example, in the four research villages of Aze Deboa, Imbidir, Terufe Kechema and Yetmen the Kembata, Gurage, Oromo and Amhara are by far the respective dominant ethnic group. This is in contrast to urban areas where different ethnic groups are more intermixed. If ethnic variation is taken as an important source of social differentiation, this fact gives the impression that the population in these villages are highly homogenous. But the sociological reports highlight that even in those villages which are dominated by one ethnic group very strong differentiations across sub-clans exist.[21] In one of the villages 32 sub-clans within the same ethnic group are reported to exist. The social distance between sub-clans can be significant as there is a hierarchical relationship between them where some of the sub-clans are even considered lowly and sub-human; in many instances marriage across sub-clans can be rare (endogamy). These sub-divisions into smaller social group have important implication in the distribution of resources and power. The current political and administrative structure of Ethiopia is based on ethnicity. Hence, the dominant ethnic group control village level political and administrative structures. From the qualitative data it's obvious that there are tensions between the dominant ethnic group and the other minorities in almost all the study villages. But at least in the three villages, differentiation across sub-clans seems to be more important than across ethnic groups as most

[21] Probably the exception is Yetmen which is almost completely dominated by the Amhara ethnic group where clans don't seem to be important.

power resides in the hands of one or two sub-clans.[22] The implication of this social fragmentation on envy and similar preferences is rather complicated but it likely creates a fertile breeding ground and these social preferences in turn can negatively affect agricultural innovation. For example, in one of the villages members of a minority ethnic group were profitably engaged in farming potatoes for the urban market but some of them were forced to abandon the enterprise because local people destroyed their crops; even though it is difficult to know who exactly did that, it is widely rumoured that members of the dominant group are likely responsible. Stealing and burning the harvest of successful members of minority groups are also reported (Esayas, 2009).[23]

In this paper we focused on agricultural innovations but farmers may also be involved in non-agricultural innovations. In fact, in the long-term since dependence on agriculture is expected to decline with growth, non-agricultural innovations are expected to become more important. Some of the anecdotal evidence from qualitative data indicates that envy becomes even stronger in relation to activities that are very different from their main farming activities; extension agents indicate the negative attitude becomes stronger when innovations are very novel (Tiumelesan, 2009). If true, this has a significant implication both for our research results as well as future rural development. At a more general level, the development of non-agricultural sectors is crucial in the structural transformation of economies and the negative consequence of envy can become a formidable obstacle against rural development.

One of our findings from analysing the underlying motives of money burning behaviour is that inequality aversion doesn't seem to be a dominant motive. This conclusion seems to be supported by some of the qualitative data coming from the focus group discussions. In the focus group discussions, using a simple hypothetical example, people were asked whether they would prefer to live in a community with high level of inequality but higher average income or a low level of inequality but lower average income. Even

[22] In the regression analyses reported in Section 4, we experimented with different social groups such as dominant and minority ethnic groups, people born in the village or outside. Since we don't have information on the clans/sub-clans of individuals we cannot explore whether the relevant social money burning rates are across clans/sub-clans.

[23] In supplementary regression analysis we explored if the relevant money burning behaviour is that of certain social groups rather than all other individuals in the village. For example, for an individual from a minority ethnic group in the village the relevant money burning rate may be that of the dominant ethnic group rather than all other people in the village. If social networks are organised around place of birth, the relevant envy can be whether the individual is born in the village or outside. To explore these, additional regressions with average money burning rates of the dominant and minority ethnic groups, of people born inside and outside the village and a combination of the two were run. In this set-up, the relevant money burning rates may be the average of the group in which the individual belongs or the average of the group to which the individual does not belong. We did not find statistically significant differences by sub-groups. The small size of our subsamples may be one reason why we fail to detect differences. Similar analysis on sub-clan membership of participants cannot be done since we do not have the information. Obviously, further research is needed.

though there were utterances that equality is good, most of the respondents preferred the unequal but richer community. Many accepted inequality almost as a natural order – "lengths of our fingers are not equal, hence inequality is inevitable". Some argued that inequality is the basis for respect among people – "if there is equality there will be no respect among people". These reinforce the result that inequality aversion probably is not a strong motivation for money burning behaviour.

As indicated in the introductory section envy can be constructive if people positively respond by emulating those that are more successful than themselves; but it can also be a destructive force if people destroy others' resource because of envious preferences. To capture the destructive aspect of envy we used money burning behaviour in an experimental game. The quantitative evidence supports that envy, even though on the individual level is correlated to higher innovation, has an externality (feedback) effect that is inimical to innovation. The qualitative evidence also seems to support the destructive effect of envy. To our knowledge this is the first paper that attempts to measure levels of envy in a real life setting using experimental games and examine its effect on innovations particularly in a developing country context.

6. Conclusion

This paper employed money burning games to analyze the impact of envy or similar social preferences on agricultural innovation in Ethiopia. We did so by combining experimental and household survey data. The money burning rates in this research are lower than found in previous experiments (Zizzo, 2003; Zizzo and Oswald, 2001), but the field implementation and strong social demands implied by the task are likely to have reduced the observed money burning, thus the money burning rate we observe can be considered as a lower bound that would otherwise be experienced in parallel situations. The significance of these effects is confirmed by the relevance of our social desirability measure in our data, although its hypothetical questionnaire nature may reduce its significance. We also considered a number of other variables, for example finding that lower digit ratios are predictors of greater money burning.

At the individual and community level, envy, as measured by money burning behaviour, is correlated to agricultural innovations. While individual money burning rates from lottery winnings are positively related to the adoption of agricultural innovations, there

is a negative social feedback effect; higher individual envy has a negative effect on agricultural innovations when there is high community level social envy.

There are three take home messages for policy makers from this research. First, envy and similar social preferences matter for adoption behaviour, even when controlling for a number of other variables. Second, while changing preferences may be difficult, there may be institutional changes that can be made to help channel such preferences in a productive rather than a destructive direction, as argued by Grolleau et al. (2009). Third, the impact of strong negative social preferences as envy may be minimised if innovations are adopted at early stage by significantly large number of people in the community. The usual model of small number of adopters followed by the majority later may not be effective; a 'big push' of innovation may be required to break a sort of low equilibrium trap created by negative social preferences. That being said, obviously further research is needed.

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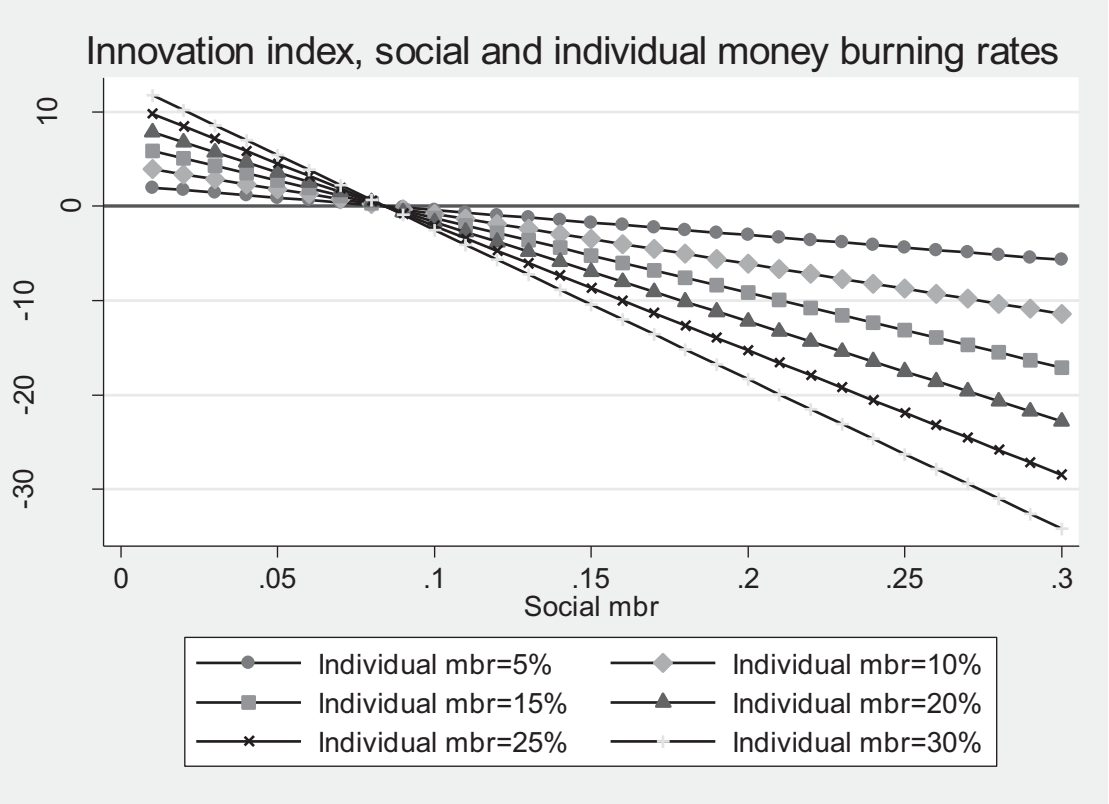
Figure 1: Partial effect of individual and interaction between individual and social money burning rates from lottery earnings on innovation index



Note: Each line is drawn by fixing individual money burning rates at the given levels as indicated in the legend; coefficients of the OLS model (3) from Table 5 are used.

Table 1. Money Burning Rates

	Rural	Addis Ababa	
Money burning	Random matching	Fixed matching	Random matching
From un-invested earnings	7.88	12.03	4.71
From lottery earnings	9.16	12.42	5.80
Overall	8.27	11.89	5.47

Table 2. Descriptive Statistics

		Rural	Addis Ababa	
		Random matching	Fixed matching	Random matching
Investment rates		0.29	0.49	0.63
Emotions (1-3, lower values higher emotion)	Anxiety	2.73	2.27	2.05
	Contempt	2.87	2.22	2.07
	Envy	2.87	2.42	2.14
	Fear of envy	2.79	2.28	2.22
	Happiness	1.11	1.43	1.82
	Irritation	2.78	2.40	2.22
	Jealousy	2.81	2.13	2.25
	Joy	1.16	1.47	1.57
	Shame	2.66	2.75	2.60
	Surprise	1.19	1.60	1.65
Big Five (scale 1-5, higher value mean more)	Extraversion	3.10	3.48	3.55
	Agreeableness	3.67	3.61	3.50
	Conscientiousness	4.00	4.12	3.88
	Neuroticism	2.49	2.61	2.42
	Openness	3.55	3.49	3.44
Understand (1-5, higher values means less)	Self-perceived understanding	2.06	1.81	1.97
Social desirability scale (scale 0-10, higher values mean more)		6.40	4.57	4.62
Digit ratios	Right digit ratio	0.96	0.95	0.96
	Left digit ratio	0.96	0.96	0.97

Mean values for rural sample			
Land size (ha)	1.16	Primary education	0.35
Male	0.65	Secondary education	0.12
Household size	6.66	Higher education	0.03
Age	46.24	Orthodox	0.40
Married	0.79	Muslim	0.16
Born in this village	0.85	Protestant	0.31
Father born in this village	0.75	Catholic	0.13
Mother born in this village	0.60		

Table 3. Money Burning Rates - Seemingly Unrelated (SUR) Regressions

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
VARIABLES	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott
Investment	0.002	-0.012	0.004	-0.015	-0.001	-0.010	-0.000	-0.012	-0.015	-0.024	-0.012	-0.024	-0.012	-0.027
	(0.017)	(0.019)	(0.018)	(0.020)	(0.019)	(0.020)	(0.019)	(0.020)	(0.019)	(0.020)	(0.019)	(0.020)	(0.020)	(0.021)
AAU	-0.024*	-0.025	0.117*	0.249***	0.000	0.256***	0.235***	0.015	0.007	0.871***	0.022	0.840***	-0.006	0.000
	(0.014)	(0.016)	(0.068)	(0.075)	(0.037)	(0.076)	(0.085)	(0.039)	(0.036)	(0.152)	(0.037)	(0.155)	(0.042)	(0.000)
Fixed groups	0.071***	0.053***	0.071***	0.053***	0.076***	0.049***	0.074***	0.047***	0.073***	0.043***	0.061***	0.033**	0.070***	0.030*
	(0.013)	(0.015)	(0.014)	(0.015)	(0.015)	(0.016)	(0.015)	(0.016)	(0.014)	(0.016)	(0.015)	(0.016)	(0.016)	(0.017)
Session 2	-0.002	-0.004	-0.005	-0.007	-0.006	-0.004	-0.006	-0.005	-0.010	-0.010	-0.008	-0.008	-0.012	-0.008
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)	(0.010)
Stage 2	-0.041***	-0.045***	-0.041***	-0.046***	-0.042***	-0.046***	-0.040***	-0.044***	-0.040***	-0.045***	-0.040***	-0.044***	0.430***	0.602***
	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)	(0.011)	(0.009)	(0.011)	(0.009)	(0.010)	(0.009)	(0.010)	(0.163)	(0.167)
Stages 3	-0.058***	-0.064***	-0.059***	-0.064***	-0.061***	-0.061***	-0.058***	-0.057***	-0.058***	-0.056***	-0.058***	-0.055***	0.414**	0.594***
	(0.009)	(0.010)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.163)	(0.168)
High income	0.012	0.001	0.015*	0.002	0.014*	0.003	0.016**	0.004	0.015*	0.001	0.015*	-0.001	0.010	-0.004
	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)	(0.010)
Male			-0.023**	0.007	-0.023**	0.006	-0.024**	0.004	-0.025**	0.004	-0.023**	0.007	-0.015	0.013
			(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.010)	(0.011)	(0.011)	(0.012)
Age (log)			0.001	-0.026	0.001	-0.027	-0.006	-0.024	-0.004	-0.023	-0.002	-0.021	-0.003	-0.021
			(0.017)	(0.019)	(0.017)	(0.019)	(0.017)	(0.019)	(0.017)	(0.019)	(0.017)	(0.019)	(0.019)	(0.021)
Muslim			0.003	0.013	0.003	0.012	0.011	0.019	0.005	0.011	0.003	0.009	0.003	0.003
			(0.015)	(0.016)	(0.015)	(0.016)	(0.014)	(0.016)	(0.014)	(0.016)	(0.014)	(0.016)	(0.016)	(0.017)
Protestant			-0.001	-0.013	-0.001	-0.013	-0.017	-0.019	-0.021*	-0.026*	-0.019	-0.023*	-0.026*	-0.038**
			(0.012)	(0.014)	(0.012)	(0.014)	(0.012)	(0.014)	(0.012)	(0.014)	(0.012)	(0.014)	(0.014)	(0.015)
Catholic			0.007	0.021	0.007	0.021	0.006	0.023	0.006	0.023	0.006	0.025	-0.002	0.002
			(0.018)	(0.020)	(0.018)	(0.020)	(0.018)	(0.020)	(0.018)	(0.020)	(0.018)	(0.020)	(0.020)	(0.021)
Other religions			-0.037	-0.060**	-0.036	-0.061**	-0.043*	-0.067**	-0.040	-0.065**	-0.048*	-0.074**	-0.035	-0.060**
			(0.025)	(0.027)	(0.025)	(0.027)	(0.026)	(0.029)	(0.025)	(0.029)	(0.026)	(0.029)	(0.027)	(0.029)
Primary			0.015	0.012	0.016	0.012	0.015	0.007	0.013	0.007	0.012	0.003	0.009	0.005
			(0.011)	(0.013)	(0.011)	(0.013)	(0.011)	(0.013)	(0.011)	(0.012)	(0.011)	(0.013)	(0.013)	(0.014)
Secondary			0.011	0.010	0.011	0.009	0.000	0.002	0.002	0.004	0.002	-0.001	0.008	0.005
			(0.017)	(0.019)	(0.017)	(0.019)	(0.016)	(0.019)	(0.016)	(0.018)	(0.016)	(0.019)	(0.019)	(0.020)
Higher/vocational			-0.019	-0.047	-0.018	-0.049	-0.015	-0.046	-0.013	-0.042	-0.017	-0.046	-0.033	-0.052
			(0.031)	(0.034)	(0.031)	(0.034)	(0.030)	(0.033)	(0.029)	(0.033)	(0.029)	(0.033)	(0.033)	(0.035)
Extraversion							-0.010***	-0.006*	-0.009***	-0.005	-0.010***	-0.006*	-0.008**	-0.002
							(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Agreeableness							-0.006**	-0.002	-0.006***	-0.003	-0.006***	-0.003	-0.004	-0.001
							(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Conscientiousness							-0.002	-0.000	-0.002	-0.001	-0.003	-0.002	-0.003	0.001

Table 3. Money Burning Rates - Seemingly Unrelated (SUR) Regressions

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
VARIABLES	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott
							(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Neuroticism							-0.003	0.001	-0.004*	0.000	-0.004*	0.000	-0.003	0.003
							(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Openness							0.000	-0.006**	0.001	-0.006**	0.001	-0.007**	-0.003	-0.009***
							(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
SDS							0.006***	0.000	0.006**	0.000	0.007***	0.001	0.004	0.002
							(0.002)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Right digit ratio									-0.246*	-0.452***	-0.239*	-0.430***	-0.270*	-0.529***
									(0.129)	(0.145)	(0.129)	(0.145)	(0.146)	(0.159)
Left digit ratio									-0.079	-0.079	-0.052	-0.075	-0.006	0.142
									(0.140)	(0.158)	(0.141)	(0.160)	(0.156)	(0.169)
Inequality aversion?														
% high income					0.019		0.027		0.024		0.022		0.080	
					(0.044)		(0.043)		(0.043)		(0.043)		(0.053)	
Sum not invested					-0.001		-0.000		-0.001		-0.001		-0.001	
					(0.001)		(0.001)		(0.001)		(0.001)		(0.001)	
% high income2						0.015		0.017		0.018		0.015		0.017
						(0.014)		(0.014)		(0.014)		(0.014)		(0.015)
Sum lottery wins						-0.000		-0.000*		-0.000		-0.000		0.000
						(0.000)		(0.000)		(0.000)		(0.000)		(0.000)
Retaliation/reciprocity?														
Lag AMBNI													-0.002	-0.005
													(0.005)	(0.005)
Lag AMBLW													0.006*	0.008**
													(0.003)	(0.004)
Emotions														
Surprise											0.014	0.016	-0.010	-0.001
											(0.015)	(0.017)	(0.018)	(0.020)
Shamed											-0.006	-0.021**	0.002	-0.013
											(0.009)	(0.010)	(0.010)	(0.011)
Joy											0.011	0.005	0.001	0.047
											(0.026)	(0.029)	(0.029)	(0.031)
Jealousy											0.014	0.008	0.015	0.009
											(0.011)	(0.012)	(0.012)	(0.013)
Irritation											-0.012	-0.013	-0.018*	-0.028**
											(0.009)	(0.010)	(0.010)	(0.011)
Happiness											0.035	0.013	0.037	-0.031
											(0.022)	(0.025)	(0.025)	(0.027)
Fear of envy											0.027***	0.025**	0.020*	0.009

Table 3. Money Burning Rates - Seemingly Unrelated (SUR) Regressions

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
VARIABLES	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott
											(0.010)	(0.011)	(0.011)	(0.012)
Envy											-0.017	-0.020*	-0.008	-0.000
											(0.011)	(0.012)	(0.012)	(0.013)
Contempt											-0.005	-0.005	0.007	0.006
											(0.011)	(0.013)	(0.012)	(0.014)
Anxiety											-0.008	-0.011	-0.005	-0.005
											(0.010)	(0.011)	(0.011)	(0.012)
Location dummies (Addis Ababa omitted)														
Yetmen	0.012	-0.016	0.120*	0.214***	0.014	0.216***	0.235***	-0.027	0.003	0.824***	-0.000	0.771***	0.003	-0.061
	(0.013)	(0.015)	(0.070)	(0.077)	(0.017)	(0.077)	(0.087)	(0.020)	(0.016)	(0.152)	(0.017)	(0.155)	(0.019)	(0.041)
T. Kechema	0.002	-0.003	0.104	0.226***	0.001	0.225***	0.213**	-0.031	-0.008	0.831***	-0.010	0.780***	-0.003	-0.035
	(0.013)	(0.015)	(0.069)	(0.076)	(0.016)	(0.076)	(0.088)	(0.019)	(0.016)	(0.151)	(0.016)	(0.155)	(0.018)	(0.040)
Imdibir	0.003	0.000	0.102	0.224***	0.000	0.223***	0.225**	-0.021	0.000	0.837***	0.000	0.789***	0.000	-0.036
	(0.013)	(0.000)	(0.070)	(0.077)	(0.000)	(0.077)	(0.089)	(0.019)	(0.000)	(0.152)	(0.000)	(0.155)	(0.000)	(0.041)
Aze Deboa	0.000	-0.009	0.109	0.236***	0.002	0.237***	0.243***	0.000	0.019	0.861***	0.013	0.805***	0.011	-0.013
	(0.000)	(0.015)	(0.071)	(0.078)	(0.018)	(0.079)	(0.088)	(0.000)	(0.017)	(0.154)	(0.018)	(0.157)	(0.021)	(0.043)
Constant	0.102***	0.139***	0.000	0.000	0.121	0.000	0.000	0.337***	0.561***	0.000	0.473***	0.000	0.000	0.000
	(0.013)	(0.014)	(0.000)	(0.000)	(0.084)	(0.000)	(0.000)	(0.087)	(0.145)	(0.000)	(0.147)	(0.000)	(0.000)	(0.000)
Observations	1048	1048	1027	1027	1027	1027	1004	1004	990	990	990	990	554	554
R-squared	0.067	0.054	0.075	0.068	0.074	0.070	0.096	0.081	0.108	0.101	0.127	0.117	0.125	0.119

Notes: mbrnotinv = money burning rate from non-investment; mbrlott = money burning rate from lottery earnings; Investment = proportion of initial endowment invested on lottery; Lag AMBNI = Lag of actual money burning from not invested; Lag AMBLW = lag of actual money burning from lottery winning; % high income = % of money by high income players from total non-invested money available for burning; % high income2 = % of money by high income players from total lottery earnings available for burning; Sum not invested = total not invested money available for burning; Sum lottery wins = total lottery earnings available for burning; SDS = social desirability scale; Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0

Table 4. Innovation Index

Innovation index	Frequency	Percent	Cumulative frequency
1	19	12.67	12.67
2	21	14.00	26.67
3	30	20.00	46.67
4	29	19.33	66.00
5	21	14.00	80.00
6	22	14.67	94.67
7	6	4.00	98.67
8	2	1.33	100.00
Total	150	100.00	

Table 5. Determinants of Agricultural Innovation: OLS, Negative Binomial and Robust Regressions of Innovation Index

	OLS regression			Negative binomial regression			Robust regression		
VARIABLES	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Investment rate	-0.049	0.341	0.519	-0.039	0.070	0.102	0.201	0.770	1.406*
	(0.633)	(0.728)	(0.698)	(0.146)	(0.164)	(0.144)	(0.702)	(0.777)	(0.738)
MBR (un-invested	-21.784	-2.512	4.680	-2.941	2.816	5.060	-29.701	-11.488	-20.876
earnings)	(18.184)	(23.450)	(23.662)	(4.485)	(5.119)	(4.737)	(21.552)	(26.985)	(25.279)
MBR (lottery	21.482*	30.126**	44.438***	7.095**	9.459**	13.265***	21.982	32.712*	37.368*
earnings)	(11.064)	(14.109)	(16.148)	(3.514)	(4.219)	(4.608)	(16.577)	(18.930)	(18.960)
SMBR x MBR	294.199	50.840	-39.468	42.976	-28.521	-56.012	390.837	162.377	290.280
(un-invested earnings)	(232.668)	(297.326)	(300.340)	(57.163)	(64.986)	(60.141)	(283.277)	(351.341)	(329.090)
SMBR x MBR	-250.650*	-357.847**	-527.769***	-84.562**	-115.181**	-161.445***	-251.537	-384.232*	-442.999**
(lottery earnings)	(130.704)	(167.070)	(190.302)	(42.728)	(51.000)	(55.288)	(189.618)	(217.108)	(217.953)
	Individual and household characteristics								
Land size (log)	0.092	0.063	0.081	0.021	0.012	0.019	0.095	0.072	0.105
	(0.094)	(0.092)	(0.085)	(0.023)	(0.021)	(0.021)	(0.099)	(0.108)	(0.107)
Male	0.437	0.541	0.664*	0.127	0.165**	0.207**	0.372	0.431	0.262
	(0.364)	(0.376)	(0.389)	(0.089)	(0.083)	(0.082)	(0.320)	(0.364)	(0.340)
Household size (log)	0.001	-0.012	-0.061	-0.014	-0.016	-0.026	0.147	0.406	0.559**
	(0.370)	(0.414)	(0.403)	(0.078)	(0.080)	(0.069)	(0.268)	(0.303)	(0.281)
Age (log)	-0.261	-0.191	-0.420	-0.077	-0.060	-0.120	-0.177	-0.297	-0.372
	(0.470)	(0.503)	(0.531)	(0.108)	(0.112)	(0.109)	(0.470)	(0.518)	(0.489)
Married	0.540	0.523	0.570	0.171*	0.163	0.184*	0.539	0.591	0.852**
	(0.360)	(0.384)	(0.425)	(0.098)	(0.101)	(0.100)	(0.347)	(0.381)	(0.365)
Born in the village	0.420	0.370	0.410	0.109*	0.109	0.118	0.449	0.496	0.637*
	(0.258)	(0.335)	(0.353)	(0.066)	(0.079)	(0.076)	(0.333)	(0.377)	(0.353)
	Education (no education omitted)								
Primary education	0.157	0.027	-0.235	0.032	-0.007	-0.095	0.068	-0.170	-0.595*
	(0.270)	(0.276)	(0.318)	(0.063)	(0.063)	(0.066)	(0.281)	(0.324)	(0.316)
Secondary education	-0.264	-0.200	-0.459	-0.052	-0.036	-0.132	-0.460	-0.699	-1.084**
	(0.357)	(0.414)	(0.463)	(0.089)	(0.101)	(0.113)	(0.386)	(0.430)	(0.428)
Higher education	-0.964*	-1.065	-1.585**	-0.262*	-0.318*	-0.478***	-1.183	-1.560**	-2.230***
	(0.577)	(0.645)	(0.649)	(0.159)	(0.165)	(0.141)	(0.721)	(0.778)	(0.736)

Table 5. Determinants of Agricultural Innovation: OLS, Negative Binomial and Robust Regressions of Innovation Index

	OLS regression			Negative binomial regression			Robust regression		
VARIABLES	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
	Religion (Orthodox Christian omitted)								
Muslim	0.077	0.136	0.069	-0.017	-0.015	-0.016	0.132	0.274	0.213
	(0.321)	(0.367)	(0.385)	(0.080)	(0.089)	(0.088)	(0.359)	(0.398)	(0.373)
Protestant	-0.807	-0.854	-0.953	-0.245**	-0.271*	-0.280**	-0.578	-0.317	-0.541
	(0.505)	(0.600)	(0.618)	(0.123)	(0.140)	(0.132)	(0.455)	(0.515)	(0.495)
Catholic	-0.316	-0.388	-0.592*	-0.228*	-0.276**	-0.334***	-0.322	-0.477	-0.737*
	(0.355)	(0.378)	(0.333)	(0.129)	(0.129)	(0.115)	(0.411)	(0.445)	(0.433)
	Personality and social desirability scale								
Extraversion		-0.019	0.037		0.024	0.031		-0.024	0.297
		(0.318)	(0.325)		(0.064)	(0.063)		(0.260)	(0.245)
Agreeableness		-0.083	-0.041		-0.011	0.003		-0.025	-0.037
		(0.154)	(0.155)		(0.037)	(0.034)		(0.162)	(0.155)
Conscientiousness		-0.089	-0.148		-0.028	-0.047		-0.087	-0.141
		(0.122)	(0.129)		(0.028)	(0.029)		(0.139)	(0.135)
Neuroticism		0.105	0.155		0.035	0.054		0.207	0.337**
		(0.143)	(0.162)		(0.038)	(0.041)		(0.146)	(0.144)
Openness		-0.180	-0.215		-0.055	-0.070*		-0.215	-0.268
		(0.150)	(0.154)		(0.038)	(0.037)		(0.172)	(0.168)
SDS		0.056	0.049		0.013	0.007		0.081	0.119
		(0.076)	(0.078)		(0.017)	(0.017)		(0.077)	(0.073)
	Digit ratios								
Right-hand digit ratio		-3.406	-4.917		-0.907	-1.420*		-3.915	-4.599
		(3.519)	(3.978)		(0.763)	(0.816)		(3.541)	(3.396)
Left-hand digit ratio		1.679	2.616		0.356	0.657		1.757	2.205
		(3.781)	(4.002)		(0.831)	(0.866)		(3.894)	(3.689)
	Emotions and subjective well-being								
Contempt			-0.165			-0.041			0.090
			(0.471)			(0.120)			(0.415)
Irritation			-0.030			-0.026			-0.183
			(0.331)			(0.074)			(0.365)

Table 5. Determinants of Agricultural Innovation: OLS, Negative Binomial and Robust Regressions of Innovation Index

	OLS regression			Negative binomial regression			Robust regression		
VARIABLES	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Surprise			-0.579			-0.101			-0.659
			(0.383)			(0.087)			(0.535)
Envy			-0.623			-0.179*			-0.467
			(0.477)			(0.099)			(0.445)
Jealousy			0.188			-0.009			0.456
			(0.299)			(0.065)			(0.341)
Fear of envy			-0.178			-0.045			-0.339
			(0.292)			(0.076)			(0.308)
Joy			3.251***			1.330***			2.916**
			(0.733)			(0.170)			(1.462)
Anxiety			0.147			0.053			-0.212
			(0.331)			(0.086)			(0.355)
Happiness			-2.760***			-1.190***			-2.384
			(0.844)			(0.198)			(1.568)
Shame			-0.038			-0.019			-0.018
			(0.277)			(0.070)			(0.277)
Subjective well-being			0.146**			0.046***			0.137**
			(0.071)			(0.018)			(0.069)
	Village dummies (Yetmen omitted)								
T. Kechema	1.497***	1.388***	1.751***	0.382***	0.368***	0.453***	1.578***	1.412***	2.000***
	(0.389)	(0.451)	(0.472)	(0.086)	(0.094)	(0.090)	(0.456)	(0.517)	(0.501)
Imdibir	-1.020**	-1.031**	-0.257	-0.402***	-0.405***	-0.180	-0.938*	-0.838	0.026
	(0.424)	(0.452)	(0.510)	(0.130)	(0.128)	(0.132)	(0.509)	(0.554)	(0.587)
Aze Deboa	2.106***	1.946***	2.342***	0.538***	0.499***	0.598***	1.853***	1.253*	1.888***
	(0.609)	(0.741)	(0.734)	(0.141)	(0.161)	(0.148)	(0.563)	(0.674)	(0.631)
Constant	3.485*	5.685	6.345	1.290***	1.861**	2.060**	2.821	5.091	3.309
	(1.963)	(4.082)	(4.062)	(0.455)	(0.918)	(0.881)	(1.960)	(4.096)	(4.016)

Table 5. Determinants of Agricultural Innovation: OLS, Negative Binomial and Robust Regressions of Innovation Index

	OLS regression			Negative binomial regression			Robust regression		
VARIABLES	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Observations	145	139	139	145	139	139	145	139	139
R-squared	0.612	0.637	0.681				0.585	0.601	0.697

Note: MBR: money burning rate; SMBR: social money burning rate; both MBR and SMBR are defined with respect to other un-invested earnings or lottery earnings (this is specified in brackets); Land size is specified in hectares; SDS = Social Desirability Scale; standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Adoption of fertiliser, rain harvesting and improved seeds: Probit estimates

	(1)	(2)	(3)
	Fertiliser	Rain harvesting	Improved seeds
Investment rate	2.780***	-4.268***	4.165***
	(0.980)	(1.623)	(1.109)
MBR (un-invested earnings)	2.193	136.678**	64.844**
	(34.794)	(56.967)	(31.166)
MBR (lottery earnings)	48.801*	47.646	64.407***
	(26.118)	(37.015)	(24.740)
SMBR x MBR	-75.948	-1,748.122**	-858.491**
(un-invested earnings)	(464.870)	(717.348)	(407.704)
SMBR x MBR	-518.812*	-550.446	-711.982**
(lottery earnings)	(289.405)	(444.235)	(286.631)
Individual and household characteristics			
Land size (log)	-0.301**	-0.038	-0.228**
	(0.146)	(0.339)	(0.113)
Male	1.381***	-0.419	1.333***
	(0.443)	(0.732)	(0.395)
Household size (log)	0.915***	0.694	-0.425
	(0.304)	(0.556)	(0.312)
Age (log)	1.531**	-0.722	1.438***
	(0.679)	(0.877)	(0.500)
Married	0.057	-0.294	0.677
	(0.463)	(0.579)	(0.492)
Born in the village	-0.495	1.927*	0.330
	(0.512)	(1.045)	(0.419)
Education (no education omitted)			
Primary education	0.943*	-0.054	0.276
	(0.514)	(0.595)	(0.297)
Secondary education	1.411**	-1.405	0.810
	(0.663)	(0.880)	(0.592)
Higher education	-0.390	0.000	0.768
	(1.025)	(0.000)	(0.789)
Religion (Orthodox Christian omitted)			
Muslim	0.392	-1.547	0.045
	(0.548)	(0.973)	(0.391)
Protestant	-0.574	-6.958***	-0.512
	(0.648)	(2.414)	(0.625)
Catholic	-0.656	-4.836***	-3.679***
	(0.502)	(1.816)	(0.936)
Personality & social desirability scale			
Extraversion	0.057	-0.496	0.381
	(0.322)	(0.534)	(0.340)
Agreeableness	-0.039	-0.367	-0.192
	(0.208)	(0.290)	(0.182)
Conscientiousness	0.183	-1.237**	-0.042
	(0.167)	(0.534)	(0.136)
Neuroticism	0.471**	0.669**	0.141
	(0.201)	(0.310)	(0.168)
Openness	-0.224	0.321	-0.378
	(0.218)	(0.339)	(0.236)
SDS	0.016	0.066	0.217**
	(0.102)	(0.157)	(0.089)
Digit ratios			

Table 6: Adoption of fertiliser, rain harvesting and improved seeds: Probit estimates

	(1)	(2)	(3)
	Fertiliser	Rain harvesting	Improved seeds
Right-hand digit ratio	-7.031	11.551	-10.039**
	(5.131)	(10.117)	(5.051)
Left-hand digit ratio	0.832	-0.891	9.664*
	(7.049)	(9.240)	(5.119)
Emotions and subjective well-being			
Contempt	0.868*		0.231
	(0.518)		(0.500)
Irritation	0.866	1.775***	0.213
	(0.552)	(0.617)	(0.424)
Surprise	-1.097	0.789	-2.495***
	(0.782)	(1.409)	(0.724)
Envy	-1.597***	-0.308	-0.970*
	(0.581)	(0.910)	(0.539)
Jealousy	-0.257	-1.450**	0.752*
	(0.455)	(0.720)	(0.428)
Fear of envy	0.968**	-4.911***	0.009
	(0.418)	(1.592)	(0.340)
Joy	6.702***	-2.460	9.772***
	(1.179)	(2.179)	(1.392)
Anxiety	0.883*	1.824***	0.576
	(0.463)	(0.679)	(0.514)
Happiness	-5.079***	-3.207	-9.035***
	(1.341)	(1.964)	(1.425)
Shame	-0.015	-2.289*	0.016
	(0.384)	(1.274)	(0.330)
Subjective well-being	0.115	0.520**	0.148
	(0.097)	(0.211)	(0.091)
Village dummies			
T. Kechema	-0.384	-1.401	2.018***
	(0.798)	(0.973)	(0.643)
Imdibir	-3.367***	-3.205**	0.207
	(0.798)	(1.311)	(0.650)
Aze Deboa	-1.072	6.277***	1.472**
	(0.939)	(2.173)	(0.750)
Constant	-3.000	-2.456	-7.897*
	(5.671)	(9.991)	(4.671)
No. of observations	180	175	180

Note: MBR: money burning rate; SMBR: social money burning rate; both MBR and SMBR are defined with respect to other un-invested earnings or lottery earnings (this is specified in brackets); Land size is specified in hectares; SDS = Social Desirability Scale; Yetmen provides baseline in relation to village dummies; standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1