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 behavior, experimentally measured envious preferences are negatively correlated to real life agricultural innovations.

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

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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. The experiment is run with a sample of subjects on which information on their real life decisions is available. Growing 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 compared to others. In this paper we adopt a broad definition of envy that includes the psychological emotion of envy and also related social preferences (such as fairness, reciprocity and inequality aversion) which under some range and context may operate equivalently in terms of a negative weight placed on the consumption of other agents.[1] Mui (1995) gives examples from reforming East European countries and China of how envy may have constrained the emergence of entrepreneurs. If worse off people try to catch up by working harder and channel envy to productive activities (Breitmoser et al. 2010) envy will 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 on innovation may be institutionally and culturally specific (e.g., Grolleau et al. 2009). It is more significant when the moral cost of burning is lower (see Abbink and Herrmann, 2011). It fits with a small but growing literature, on what Herrmann and Orzen (2008) have dubbed *homo rivalis* behavior.

While anthropologists, sociologists and psychologists have long emphasized the importance of envy (Bailey 1971; Schoeck 1966), more quantitative research on its potential

[1] See Zizzo (2008) for a review. For a characterization of the psychological emotion of envy, see e.g. Alicke and Zell (2008). For an early experimental paper and a more recent analysis on envy in a public good contribution setup, see Saijo and Nakamura (1995) and Saijo (2008) respectively.

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

role in developing countries is almost non-existent. This paper attempts to contribute towards filling this gap. We employ a money burning experimental design (Zizzo and Oswald 2001; Zizzo 2003) in Ethiopian rural villages, with additional sessions with students of Addis Ababa University in an urban setting. The money burning game has two parts: in the first, a distribution of resources is induced; in the second, people can use their money to decrease others' money ('burn' money).[3]

After identifying the level of envy as we have defined it, the paper examines their determinants and then considers the correlation between money burning behavior and real life agricultural innovations. The analysis of money burning behavior in the game and real life agricultural innovations indicate that, given individual behavior, the envious preferences of others reduce agricultural innovations.

The rest of the paper is organized 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.

2. Experimental design

The experimental game has two parts. First, players are randomly given large or small amounts of money to induce inequality and then participants play a lottery; similar to real life innovations the lottery is a risky undertaking with a relatively large potential return. Second, players are allowed to decrease the money of others at their own cost (money burning).

In a session of a game thirty individuals participate and are randomly given large (Birr[4] 15) or small (Birr 7) amounts of money; we shall call the first high and the second low income players. The players are then divided into five groups with six players in each group,

[3] A variant of this experimental setup has stealing allowed in place of money burning (Falk and Fischbacher 2002) and shows evidence of reciprocal behavior. For an example of evidence for reciprocity in a developmental setting but a different context, see Barr and Serneels (2009).
[4] Birr is the national currency of Ethiopia. At the time the games were played US$1 was worth around Birr 8.

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. 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 from the lottery. All six members of a group are then asked how much of the money of others in their group they would like to 'burn'. Players have to pay 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 un-invested money and lottery earnings in order to capture potential heterogeneity.

After eliciting the money burning decisions, a random dictator design is used to determine the actual money to be burnt. Even though the amounts the six players want to burn from the money of the other five are recorded, only the choice of one is randomly implemented.[5]

The above described game is repeated three times (three *stages*). Two sessions of 30 subjects each were run in each of the four rural villages (a total of 240 players). In each stage subjects were randomly matched with their group members (*variable groups*). Two variable group sessions were also conducted at Addis Ababa University with 60 students. At the university, additional two sessions in which the same subjects are matched in each group in the three stages (*fixed groups*) were run with 60 students.

At the end of the experiment, participants went home with all the money accumulated over the three stages plus a participation fee of Birr 40. The mean payment, including the

[5] This random dictator design follows Zizzo (2003). Note that, if the money burning decisions of all the participants had been implemented, potentially the money to be burnt could be more than the money given to players.

participation fees, was around Birr 80, i.e., approximately U.S. $10 or around 4 days of wages for unskilled labor.

The next section contains further details on data collection.

3. Data collection

The key data for this research is gathered from four Peasant Associations (villages) in Ethiopia; Peasant Associations are the lowest subdivision of state administration in rural areas. The villages are part of a previous panel survey with rich and detailed household data that goes as far back as 1994. The four were selected from more than 15 villages covered by the survey to reflect some of the major farming systems and ethnic variations in the country.

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. This region is the heartland of a farming system based on *enset*[6] characterized by the use of the hoe rather than the ox-plough. The majority of the people are members of the Gurage, a highly entrepreneurial ethnic group active in commerce. Aze Deboa is a village in the Kembata region (dominated by an ethnic group of the same name). Even though *enset* is important, cereals and other crops play a more prominent role compared to Imdibir. Terufe Kechema is located near the town of Shashemene, one of the biggest commercial centers in the south. The region is dominated by the Oromo, the most populous ethnic group in Ethiopia. Yetmen is located in northwest of Addis Ababa and like most regions in the north farming is dominated by cereals and the ox plough. Yetmen and the surrounding area are well known for the production of *teff*, a type of cereal used in Ethiopia, and because of the strong demand for *teff* the area is relatively prosperous. Important ethnic and farming differences are captured by these villages. Two of the most populous ethnic groups in Ethiopia – Oromo and Amhara –

[6] *Enset* is the false banana tree and is used as staple food among many ethnic groups in southern Ethiopia.

are the dominant ethnic groups in the two sites, Terufe Kechema and Yetmen, respectively. Similarly, the villages also capture important variations in agricultural systems: the ox-plough versus hoe-culture, *enset* versus cereals. The spread of agricultural innovations is also varied; for example, the percentages of farmers using fertilizer range from a low of 45% in Imdibir to a high of 97% in Yetmen.

As indicated before, even though the main data for this project came from the money burning experimental game, additional data were also collected. Pre-game questionnaires provided background information on participants, agricultural practices and innovations and personalities. Post-game questionnaires captured the players' experience of the game. Lengths of ring and index fingers were measured to capture digit ratios.[7] While the above-mentioned research instruments were administered on individuals participating in the money burning experimental games, additional information was also gathered through focus group discussions. In each village, four focus groups – two with males and two with females - were organized. In addition, four sociology lecturers from Addis Ababa University were commissioned to write sociological reports for each village using both 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. Due to low mobility/migration in rural Ethiopia tracking households that were interviewed in the last round of the rural household survey in 2004 was not too difficult. While 60 individuals were required for the two sessions of the game, the household survey covered more households in

[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.

each village. Some individuals (33 out of 240, i.e. 14%) did not turn up at the time of the game and had to be replaced by others not originally covered by the ERHS.

The games were also played with 120 Addis Ababa University students 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 rural ones, two sessions with fixed groups of players were also conducted; this was to increase the number of independent observations and improve statistical power as well as examine the effect of fixed groups on money burning behavior.

In three villages halls that accommodate players sitting reasonably far apart were used; in the remaining one village the game was played in two big tents. In Addis Ababa, a very big hall that can accommodate large audiences was used. Research assistants were intensively trained and one of the authors of this paper oversaw the conduct of all the experimental sessions.

In all cases, participants came to a designated place creating a more controlled environment compared to playing the games sequentially at different times and places like the homes of players. But significant differences with experimental game laboratories in Western universities should be noted. In the rural areas all individuals were drawn from the same village. Even though players could not identify who their group members were, each participant saw the remaining players most or all of whom were likely to be known to him/her. Similarly, university students were drawn from a small number of faculties hence are likely to know each other. This is different from complete anonymity in proper experimental labs where individuals interact through computer terminals. The lack of anonymity is likely to increase pro-social behavior, and so we believe the money burning rates are likely to be biased downwards.

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 the link between money burning and innovations.

4.1 General overview

About two-thirds of the 360 subjects were male in the rural villages (65%) and almost all in Addis Ababa (91%). While the average age of university students was 21, it was 46 in the villages. Almost all subjects from the villages were farmers (94%), with percentages no lower than 88% in any individual village.

Money burning rates are defined as the amount of money that subjects burn out of the total money available to burn. Table I shows the money burning rates.

(*Insert Table I about here*.)

Mean money burning rates are about 12% with fixed groups, and about half as much in Addis Ababa with variable groups, with the rural villages situated in the middle. There is more money burning with fixed than with variable groups, as confirmed by a Mann Whitney test on the Addis Ababa sample ($P = 0.05$).[8]

Conversely, there is no significant difference in money burning rates between variable groups in Addis Ababa and rural villages; more interestingly, there is also no significant difference between money burning rates from un-invested and lottery earnings.

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

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

(*Insert Table II about here*.)

Table II 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 $P < 0.001$). As expected, digit ratios on average 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 2011) 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 $\rho = -0.690$ ($P = 0.001$) between our social desirability measure and the stated degree of envy at the end of the 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; Rammstedt and John 2007; Volk et al., 2011) and shows no statistically significant difference on any personality dimension except for Extraversion,[9] 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 $\rho = -0.704$, $P < 0.001$).[10] 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

[9] The other four dimensions are Agreeableness, Conscientiousness, Neuroticism and Openness.
[10] There are no statistically significant correlations between the social desirability measure and the other Big Five dimensions.

among university students (Mann Whitney P = 0.01, two tailed); Table II shows that among the university students a slightly better understanding is observed in the fixed groups.[11]

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.[12] In Addis Ababa, 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.[13] 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 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 sessions ($\rho = 0.49$, $P = 0.11$).[14] 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; $\rho = -0.826$,

[11] This is not surprising as the fixed groups environment is arguably a slightly simpler one for subjects to understand.
[12] The same relationships do not apply in relation to money burning from not invested earnings.
[13] Spearman $\rho = -0.524$ ($P = 0.183$); this suggests that, in rural villages, money burning from lottery earnings was quite independent of the amounts won, thus making the burning ratio having (possibly, if not statistically significantly so) a negative relationship.
[14] For rural villages, $\rho = 0.096$ ($P = 0.82$).

P=0.006 for rural villages). In the next sub-section we try to shed more light on the determinants of money burning.

4.2 Explaining money burning

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), whether the games are played with fixed or variable groups (the Fixed dummy) or with university students or rural inhabitants (the Addis Ababa University – AAU – dummy). In addition, we include 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 (Primary, Secondary, Higher/vocational) and religion (Muslim, Protestant, Catholic, Other Religions), personality traits captured by the Big Five (Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness) and social desirability scale (SDS), right and left digit ratios, and emotions people reported after the games.

(*Insert Table III about here.*)

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. Seemingly Unrelated Regressions

(SUR) is used since the error terms from these regressions are not independent as confirmed by the Breusch-Pagan tests.[15]

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 behavior 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 by making sure no contact occurred between the two groups, and the regression results confirm that contamination between the two sessions is avoided.

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 earnings; but money burning from lottery earnings is not significant. There is a possible gender effect 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.[16] 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 ($p < 0.05$). Orthodox Christian, Islam,

[15] In addition to the SUR, Tobits were estimated to check whether censoring due to zero money burning rates significantly affects parameter estimates. The estimates are robust to this specification change.

[16] The lack of correlation with education 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.

Protestant 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 practiced at local levels. Subjects with 'other' religions burn less money from lottery earnings than other religions; but generally they are not different in their money burning behavior with respect to non-invested money.

In all the models money burning rates are not significantly correlated to investment rates in the games (money used for lottery). This indicates that risk taking and money burning behavior 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 explore if levels of income and money burning are related, for example as predicted by inequality aversion. Note that people 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 larger 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 III under 'Inequality aversion?' represent the share of initial high income players from non-invested earnings and lottery earnings respectively. But also note that after playing the lottery the amounts of money players have had changed; hence, the income distribution at the end is not the same as the initial income distribution. 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 burn more from those that have more money. These two variables are named

'Sum not invested' and 'Sum lottery wins' in the 'inequality aversion?' part of Table III. Almost all the coefficients are not statistically significant (except for one with $P < 0.1$).[17]

These regression results do not support inequality aversion based on ratios of incomes (y/x); they do not however rule out inequality aversion that depends on absolute income differences ($y - x$, similar to Fehr and Schmidt, 1999). To clarify this, suppose y_1 and x_1 are incomes of two people and $y_1 > x_1$. If the money burner has an inequality averse utility function based on absolute income differences, U (., $y_1 - x_1$) with a negative partial effect, she will burn money to decrease this absolute difference. If subscripts 2 indicate for money after money burning, the following holds; $y_1 - x_1 > y_2 - x_2 = y_1 - y_b - x_1 + x_b$, where y_b and x_b stand for absolute money burned. This in turn implies $y_b > x_b$ meaning she burns more from the higher income in absolute terms. If the money burner has an inequality averse utility function based on proportions of income, U(., y_1/x_1) also with a negative partial effect, she will burn money to decrease this proportion implying $y_1/x_1 > y_2/x_2 = (y_1 - y_b)/(x_1 - x_b)$. After some manipulation this gives $y_b/y_1 > x_b/x_1$, i.e., the money burning rate from higher income should be greater than from the lower income. This is what is rejected by the regression results.

It is useful to verify whether higher income subjects get burned more. The problem with an absolute money burning test of this kind, however, is the ceiling effect identified in Zizzo and Oswald (2001): even if money burning were to occur at random rather than reflecting inequality aversion, since richer subjects have more money than can be burned, more money may be burned of them in absolute terms. We follow a test similar to the one in Zizzo and Oswald (2001) to address this problem. Define *burnvictim* in relation to subject *i* the amount that each other subject *j* (for $j = 1 \ldots 5$) burns from him. In relation to each stage, we determine the mean rank correlation between subject *i*'s income and burnvictim: mean ρ

[17] We also experimented by dropping and including the two sets of variables – the percentage of high income and sum of money – to see if our results are affected by multicollinearity; the results do not change.

= 0.621, 0.679 and 0.687 for stages 1, 2 and 3 respectively.[18] We then run Monte Carlo simulations where we determine randomly money burnings for the given income distributions 100 times; as a result of this process, we compute mean simulated rank correlations between income and burnvictim as equal to ρ = 0.551, 0.592 and 0.614 for stages 1, 2 and 3 respectively. This is significantly lower than the real correlations ($P < 0.001$ in sign tests). Therefore, while a large ceiling effect may exist and create a spurious correlation between one's own income and the burning activity of others towards oneself, there is evidence for income inequality in absolute terms that cannot be explained by the ceiling effect and that is consistent with inequality aversion.

RESULT 4. Money burning is not consistent with inequality aversion based on income ratios, but is consistent with the presence of an absolute income difference inequality aversion motive.

Another possible underlying motive for money burning behavior 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 lagged actual money burnings are added in the 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 from the previous stage and money burnings from non-invested money and lottery earnings are entered as separate variables (Lag AMBNI and Lag AMBLW respectively). There is some evidence that retaliatory/reciprocal considerations are possible

[18] If the money burner burns a constant amount for each subject, a correlation cannot be identified in this case; equally, however, these cases, which represent 38.3% of the observations, do not contribute towards a spurious correlation between income and absolute amount of money burned.

motives for money burning behavior especially with respect to lottery earnings ($p < 0.1$ for Lag AMBNI and 0.05 for Lag AMBLW). This effect is not restricted to fixed groups; the result holds in further regressions where these variables are interacted with the dummy for 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 burning or as a form of indirect reciprocity or a rationalization of envious behavior 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 5. Money burning is not only greater as a result of repeated interaction in fixed groups 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 behavior based on indirect reciprocity.

In section 4.1 we noted that 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).

The 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 6. 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.

Digit ratios are added to models 5, 6 and 7 to examine if underlying physiological features of individuals affect their money burning behavior. It will be recalled that lower digit ratios are associated with higher prenatal exposure of testosterone and this is expected to increase aggressiveness and competitive spirits. 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 ($P < 0.01$),[19] left hand ratios are not. The highly significant and negative correlation between right hand ratios and money burning rates of both types 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 parallels findings in the wider literature where for some

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

activities only the ratio of one hand has good predictive power (for example, see Lutchmaya et al., 2004).

RESULT 7. 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 behavior. At the end of the game, 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 significance of the variable diminishes when Lag AMBNI and Lag AMBLW are introduced ($P < 0.1$ in relation to un-invested earnings only in model 7). 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 role, and the reduced significance of 'fear of envy' when Lag AMBNI and Lag AMBLW can be seen in the light of them being better proxies for this motive. There is also some limited and partial evidence that those people who felt 'ashamed' and 'irritated' burn less out of lottery earnings. The coefficients on stated 'envy' as such are not significant.

RESULT 8. There is some evidence, consistent with a reciprocity motive, that people who reported that they felt 'fear of envy' while playing the experimental games proportionally burn more money.

To summarize, while some socio-economic characteristics like religion play a relatively weak role in determining money burning, others such as age and education are not important correlates. Personality traits and digit ratios have some explanatory power underlining the usefulness of controlling for these factors when doing research on individual behavior. There

is some evidence for an absolute income difference inequality aversion and the importance of (indirect) reciprocity motives.

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

4.3 Innovation and envy

The key objective of this research is to understand the effect of envy (interpreted as psychological envy or related social preferences, as discussed in the introduction) on real life agricultural innovations. We shall examine these issues by combining the 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 behavior in the experimental games, is expected to influence agricultural innovations through three different channels. First, individual money burning behavior likely captures relevant individual characteristics correlated to innovation behavior. For example, people willing to burn others' money are probably more aggressive and/or competitive and hence are expected to be more innovative. Second, the money burning behavior of others (*social money burning)* is also expected to affect innovation behavior; 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 behavior and innovation is expected, if everybody in the community behaves similarly the net 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:

$$I_{hv} = f(MBR_{hv}^{\ h}, MBR_{hv}^{\ v}, MBR_{hv}^{\ h} \times MBR_{hv}^{\ v} | IN_{hv}, HH_{hv}, F_v) \quad (1)$$

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

To measure the overall adoption rates of households (I_{hv} in equation (1)) a simple innovation index is computed using the ERHS data. This index captures twelve agricultural innovations; at different rounds, farmers were asked whether they grow new crops like coffee and *chat*,[20] 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 a score of 1 is given for each of these questions; 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 IV about here*.)

A tabulation of the innovation index is given in Table IV. 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

[20] *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.

innovation has been adopted by all households with the most innovative households implementing eight.

Community level envious preferences (MBR_{hv}^{v} in equation (1)) are proxied by *social money burning rates* that are computed in the following way. 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 since social money burning rates are computed by averaging the money burning rates of all other members of the same village, it is strongly correlated to village level fixed effects (F_v); consequently, the direct effect of social money burning will be absorbed in the village fixed effects and, since there are only four villages, there is no statistical variation to disentangle it from the other fixed effects. Hence, the regression estimated has the following modified form with the direct effect of social money burning (the coefficient on MBR_{hv}^{v}) absorbed in the village fixed effects:

$$I_{hv} = f(MBR_{hv}^{h}, MBR_{hv}^{h} \times MBR_{hv}^{v} | IN_{hv}, HH_{hv}, F_v) \quad (2)$$

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 V about here*.)

As indicated previously, in the experimental games players were allowed to burn money from non-invested money 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. The money burning behavior of participants in relation to 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 behavior from lottery earnings is correlated positively to agricultural innovations, the same behavior 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 V 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 I). 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_{hv} is equal to 44.438*MBR_{hv}^{h} - 527.769*MBR_{hv}^{h}*MBR_{hv}^{v}. Each line in Figure I 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 I, 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 behavior 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 rates.

(Insert Figure I 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 rates 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 V 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 V 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 usufruct basis to 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 only agricultural innovations are considered 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 behavior (in Table III) and the lack of correlation with the innovation index imply that these factors likely

influence innovations not directly but through influencing intermediary characteristics correlated to money burning behavior 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 game. These are included in the regressions because they may be reflecting some underlying states of the individuals that can affect innovation behavior. In addition to emotions, 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 is 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 did not 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. While inferences on the direction of causality can only be drawn with caution, these results are likely capturing some underlying individual characteristics relevant for innovation behavior 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 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 fertilizer and

improved seeds and harvest rain water. The yes/no responses are used to estimate probits (see Table VI for results).

(*Insert Table VI about here*.)

As in the case of the innovation index, the individual money burning rates from lottery earnings for fertilizers 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 fertilizers; $p < 0.05$ 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 is difficult to know why rain harvesting is correlated to money burning behavior in a different way compared to fertilizer and improved seeds. But it is apparent that it is a very different type of investment compared to the two. First, rain harvesting requires building relatively permanent structures like ponds; the other two do not. 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, fertilizer 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 subsidies for fertilizers 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 fertilizer 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 fertilizer 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 fertilizer and improved seeds ($P < 0.01$); but both variables are not significant for rain harvesting. Interestingly, the adoption of fertilizer 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 fertilizer. Primary and secondary education is significant only for fertilizer 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)

We have defined envy as encompassing the psychological emotion of envy and related social preferences (e.g. related to perceptions of fairness) that under some range and context imply a negative weight assigned to the consumption of other agents in one's own utility function. We have used a broad definition because, while we try to shed light on what underlies it in our experiment, it best captures the gamut of psychological motivations that may conspire towards affecting innovation not just directly but also through social effects of the kind we have identified in this paper.

Let us recapitulate the main results from the quantitative analysis. The money burning rates in this research are lower than those 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 rates we observe can be considered as a lower bound relative to what would otherwise be experienced in parallel situations. Even though some socio-economic characteristics like education and age are not significantly related to money burning behavior, there is some evidence that gender and religious beliefs (especially minority and traditional religions) are. While inequality aversion based on proportions of incomes is not supported, there is evidence for inequality aversion based on absolute income differences (such as Fehr and Schmidt, 1999). Reciprocal and/or retaliatory considerations seem to be important motives for money burning behavior. Some of the Big 5 personality dimensions like Extraversion, Agreeableness and Openness are negatively correlated to money burning behavior. The underlying physiological characteristic of individuals related to prenatal hormonal exposure as captured by digit ratios is also significantly correlated to money burning behavior. 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 behavior, higher social money burning decreases innovation. For

sufficiently high levels of money burning, this indirect effect dominates. When looking at individual innovations we find similar findings for fertilizer and improved seeds adoption, though not for rain harvesting.

As indicated before, in addition to the experimental games, sociological reports were prepared by university sociology lecturers and eight focus group discussions were conducted. Let us summarize and discuss the more relevant findings from these qualitative data.

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.[21] The negative effect on agricultural innovations is clearly highlighted by one of the farmers:

> "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 touches on an important aspect. 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 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 generalized atmosphere of fear and suspicion of witchcraft and the evil eye is usually associated with envy (Schoeck 1966).

[21] 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.

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 dominant ethnic group respectively. This is in contrast to urban areas where ethnic groups are intermixed. If ethnic variation is taken as an important source of social differentiation, this fact gives the impression that the population in these villages is highly homogenous. But the sociological reports highlight that even in those villages dominated by one ethnic group very strong differentiations across sub-clans exist.[22] 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 controls 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 power resides in the hands of one or two sub-clans.[23] 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

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

[23] 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. Unfortunately, since we do not data on the clans/sub-clans of individuals we cannot explore whether the relevant social money burning rates are across clans/sub-clans.

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 rumored 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).[24]

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 farming; 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, as the effect might be stronger for non-agricultural innovations. 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 an obstacle against rural development.

Some of the earlier sociological and psychological literature also seems to provide a similar picture. 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

[24] In supplementary regression analysis we explored if the relevant money burning behavior 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 organized 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.

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." This is consistent with the significance of envy and, through conformism, of its social dimension.

6. Conclusion

Envy, as we have defined it, can be constructive if people positively respond by emulating those who are more successful than themselves but can also be a destructive force if people destroy others' resources. To capture the destructive aspect of envy we used money burning behavior in an experimental game. The quantitative analysis finds that, controlling for various demographic, socio-economic and psychological individual characteristics, for various experimental features, and for village fixed effects, envy, as measured by money burning behavior, is correlated to agricultural innovations. Specifically, envy has an externality (feedback) effect that is inimical to innovation even though on the individual level it is correlated to higher innovation; overall, higher individual envy has a negative effect on agricultural innovations when there is high community level envy. Of course, while our results apply to innovation in general, we are making no claims that they may apply necessarily to specific innovations. That being said, the qualitative evidence also seems to support the destructive effect of envy in rural Ethiopia. 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, generally and, specifically, in a developing country context.

There are three take home messages for policy makers from this research. First, envy (broadly interpreted) matters for adoption behavior, 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 negative social preferences such as envy may be minimized 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. Obviously further research is needed.

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Table I. Money Burning Rates (%)

	Rural	Addis Ababa	
Money burning	Variable groups	Fixed groups	Variable groups
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 II. Descriptive Statistics

		Rural	Addis Ababa	
		Variable Groups	Fixed Groups	Variable Groups
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 III. Money Burning Rates - Seemingly Unrelated (SUR) Regressions

Note the dependent variables are mbrnotinv (money burning rate from non-investment) and mbrlott (money burning rate from lottery earnings) respectively.

	(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)

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

Note the dependent variables are mbrnotinv (money burning rate from non-investment) and mbrlott (money burning rate from lottery earnings) respectively.

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
VARIABLES	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott
Conscientiousness							-0.002	-0.000	-0.002	-0.001	-0.003	-0.002	-0.003	0.001
							(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

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

Note the dependent variables are mbrnotinv (money burning rate from non-investment) and mbrlott (money burning rate from lottery earnings) respectively.

	(1)		(2)		(3)		(4)		(5)		(6)		(7)	
VARIABLES	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott	mbrnotinv	mbrlott
											(0.022)	(0.025)	(0.025)	(0.027)
Fear of envy											0.027***	0.025**	0.020*	0.009
											(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: 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 IV. 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 V. 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 V. 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 V. 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 V. 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; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table VI: Adoption of fertilizer, rain harvesting and improved seeds: Probit estimates

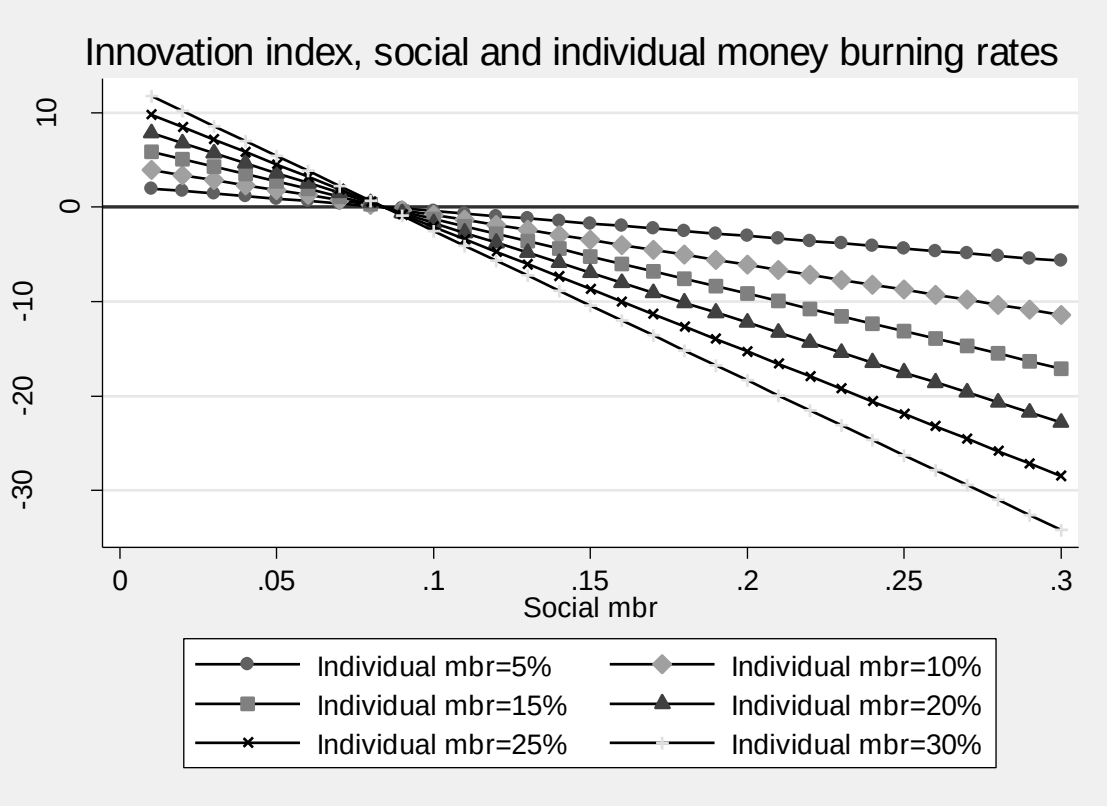
	(1)	(2)	(3)
	Fertilizer	Rain harvesting	Improved seeds
Investment rate	2.780***	-4.268***	4.165***
	(0.980)	(1.623)	(1.109)
MBR (un-invested earnings)	2.193	136.678**	64.844**
	(34.794)	(56.967)	(31.166)
MBR (lottery earnings)	48.801*	47.646	64.407***
	(26.118)	(37.015)	(24.740)
SMBR x MBR	-75.948	-1,748.122**	-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 VI: Adoption of fertilizer, rain harvesting and improved seeds: Probit estimates

	(1)	(2)	(3)
	Fertilizer	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; robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Figure I: 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 V are used.