Do Incentives matter for Knowledge Diffusion?
Experimental Evidence from Uganda.

John Sseruyange[1,2] and Erwin Bulte [2]

[1]School of Economics, Makerere University, Plot 51, Pool Road. P.O Box 7062, Kampala, Uganda. E-mail: johnsseruyange@gmail.com

[2]Development Economics Group, Wageningen University, P.O. Box 8130, 6700 EW Wageningen, Netherlands. E-mail: erwin.bulte@wur.nl

Abstract: Many development interventions involve training of beneficiaries, based on the assumption that knowledge and skills will spread "automatically" among a wider target population. However, diffusion of knowledge (or innovations) can be slow and incomplete. We use a randomized field experiment in Uganda to assess the impact of providing incentives for knowledge diffusion, and pay trained individuals a fee if they share knowledge obtained during a financial literacy training. Our main results are that incentives increase knowledge sharing, and that it may be cost-effective to provide such incentives. We also document an absence of assortative matching in the social learning process.

1. Introduction

Knowledge diffusion is a key topic in macro-economics, and a major driver of economic growth. Income differences across countries are to a large extent explained by differences in total factor productivity (Caselli and Coleman 2001), suggesting poor countries can "catch up" by adopting technologies produced elsewhere.[1] At the micro-level, this has resulted in substantial effort allocated to knowledge transfer and extension activities. Development practitioners typically assume that diffusion of knowledge and skills will "leverage" the impact of such interventions – knowledge is supposed to flow freely within social networks, eventually reaching a much larger group of agents than the sub-group initially reached by the training. While training interventions are costly, they may pass economic cost-benefit tests if transferred knowledge and skills spread to a sufficiently large number of other households or firms in the target population, affecting their poverty status as well as that of the initially-trained sub-group.

But there are barriers to the diffusion of technology and knowledge. The existence of barriers to the diffusion of technology across international borders is perhaps not surprising. Technologies may not "fit" conditions elsewhere, and often there are costs associated with adoption (such as in the case of improved seeds or fertilizer) which may be difficult to overcome if capital markets are imperfect. But even knowledge, which supposedly may spread at relatively low cost, sometimes does not travel easily – not even within organizations (Szulanski 2000), local communities (Chami et al. 2015), or tightly-knit social groups (Sayinzoga et al. 2016). In the field of development economics, which is the focus of this study, imperfect diffusion has been documented in a range of important domains, including agricultural innovations (Feder et al.

---

[1] Models of endogenous growth theory are based on the assumption that knowledge is a public good so that innovations readily spread within and across countries.

1985), health (Chami et al. 2015), and financial literacy (Sayinzoga et al. 2016). Even if individuals are connected via social networks, the spreading of knowledge beyond initial "seed nodes" typically requires time and effort on both the "supply" and the "demand" side (see below). Hence, the spreading of knowledge can be viewed as an economic process, involving an investment decision by those possessing the knowledge and those seeking to access it. Viewed in this light, it seems natural to ask whether the diffusion of knowledge can be promoted by economic incentives.

The objective of this paper is twofold. First, and most importantly, we test whether incentivizing seed nodes fosters the diffusion of knowledge within social networks. We follow important work by BenYishay and Mobarak (2016), who pioneered the use of an experimental approach in this context, but consider the case of financial knowledge (rather than an agricultural innovation).[2] Second, we probe the individual characteristics of seed nodes and their peers, and the alignment of these characteristics across them, to gain a better understanding of factors promoting diffusion. Our main results are that (i) incentivizing individuals has a large effect on the diffusion of knowledge, and (ii) that providing small monetary incentives is a cost-effective approach to foster the spread of information (compared to extending the extensive margin via additional trainings). We also find that social proximity does not foster social learning within the context we study.

We study the effect of incentives on diffusion of financial literacy knowledge with a randomized controlled trial. Our implementing partner is a local nongovernmental organization active in peri-urban Uganda, whose development strategy involves the formation of so-called self-help groups of up to 30 members. These groups receive training and support in various forms (see

---

[2] For non-experimental work pointing at the importance of incentives for diffusion, refer to Sorenson and Fleming, (2004), Lucas and Ogilvie, (2006), Alavi and Leidner (2001), and Szulanski, (2000).

below). We study a number of these groups in an RCT with two treatments arms and one control arm. Randomization occurred at two levels: we randomly allocated groups to one of the two treatment arms or the control arm, and next invited a random sub-sample of group members from treatment groups to participate in a six-day financial literacy training. Trained individuals were afterwards encouraged to share newly acquired knowledge with their fellow group members. The difference between the two treatment arms was as follows: group members in one arm were exposed to the conventional training program, and group members in the other arm received the training as well as an incentive for diffusion. Specifically, these group members were promised a monetary reward in case sufficient knowledge diffused within their self-help group. We revisited treated groups and control group after a period of 10 months, and measured the extent to which training content had spilled over to other group members.

The focus on financial literacy is timely and important. Evidence suggests the impact of microfinance (interventions) varies with levels of human capital among recipients (Bruhn et al. 2010, Sayinzoga et al. 2016), and in response many microfinance institutions and NGOs have embraced financial literacy trainings as a tool to support development (the so-called "Finance-Plus" strategy).[3] Financial literacy captures consumers' awareness, skills, and knowledge enabling them to make informed, effective decisions about financial resources. Studies across a range of countries have shown that levels of financial literacy tend to be low (Lusardi and Mitchel 2007, 2008). Focusing on developing countries, a small number of studies have probed how financial literacy affects economic behavior, including insurance adoption (Giné *et al.* 2012, Cohen and

---

[3] Financial literacy trainings are often-times part of a broader training agenda, aiming to promote modern business practices and entrepreneurship (e.g. Berge et al. 2014, Bjorvatn and Tungodden 2010, Gine and Mansuri 2014, Karlan and Valdivia 2011). The literature on the impact of business and entrepreneurship trainings on business practices and outcomes has produced mixed results, and is summarized by McKenzie and Woodruff (2014).

Young 2007), savings (Tustin 2010, Bruhn et al. 2013, Landerretche and Martínez 2013), bank account ownership (Cole *et al.* 2011), and business practices and outcomes (Sayinzoga et al. 2016).

There is very little evidence on the diffusion of financial knowledge beyond trained individuals, and the little bit of evidence that is available proves to be inconsistent. While Sayinzoga et al. (2016) find no evidence of financial knowledge spillovers beyond trained village bank representatives in rural Rwanda, Berge et al (2014) find that training content spread within borrowing groups in Tanzania. A key difference in context between these studies was that, in Tanzania, limited liability within groups implied the seed node had a direct incentive to train his peers (to reduce his own exposure to bad financial decisions of these peers). This insight speaks directly to the perspective of diffusion processes as being driven by economic considerations.

The paper is organized as follows. In the next section, we provide background to the topic of knowledge adoption and diffusion, summarizing part of the relevant literature. In section 3, we describe the details of our experiment and explain our sampling strategy. In section 4 we introduce our data and outline our identification strategy (which is relatively simple in light of the experimental nature of our data). In Section 5, we present our empirical results and attempt to unravel the factors that influence knowledge diffusion. Discussion and conclusions are presented in section 6.

2. Adoption and Diffusion

A very large literature studies the adoption of technologies in developing countries. Much of this literature focuses on the spreading of agricultural innovations, such as improved seeds and fertilizer, or bundles of agricultural activities, such as "conservation agriculture" or "system of rice intensification" (e.g., Feder et al. 1985, Knowler and Bradshaw 2007). This focus seems

appropriate in light of the importance of the agricultural sector for livelihoods in developing countries. However, other relevant domains have been studied as well, including health (e.g. bed nets, deworming pills), hygiene (water purifiers, menstrual cups), and fertility (contraceptives). A recent survey of the adoption literature is provided in Foster and Rosenzweig (2010). The diffusion of technologies that are supposed to improve human welfare is imperfect, which may be explained by a range of factors including imperfect capital markets (credit and insurance), incomplete tenure arrangements (impeding the uptake of long-term investments), and perhaps by behavioral factors (Duflo et al. 2011).

A necessary precondition for adoption is learning – learning about the existence of the innovation as well as learning how to use it. While learning about the implementation and payoffs of new technologies can occur via own experimentation and local generation of knowledge (a process involving positive external effects and strategic considerations – see Foster and Rosenzweig 1995, and Bandiera and Rasul 2006), knowledge about the *existence* of useful technologies will have to come from outside. Outside knowledge may enter local communities via government campaigns, extension activities, marketing campaigns, or informally (via social networks). Bayesian learning through social networks can be effective and rapid when innovations have large payoffs for large swaths of the population, are easily observed, and can be applied homogenously across space. In early stages of the green revolution, the adoption of new technology spread very quickly across large parts of India. Similarly, there is evidence of rapid social learning and diffusion in the domain of health and sanitary innovations (Dupas 2014, Oster and Thornton 2009).

However, the conditions for Bayesian learning are not always met, and the evidence of widespread social learning is "decidedly mixed" (Breza 2015). Diffusion of knowledge varies with

the structure of social networks and the position of innovators within that network (e.g. Banerjee et al. 2013, Cai et al. 2015, Beaman et al. 2015). Moreover, interventions may have heterogeneous payoffs varying with individual attributes (e.g. Suri 2011), so information acquired by one farmer may be uninformative for his neighbor (Munshi 2004). In this context, individuals should carefully target whose behavior and outcomes to observe, paying special attention to people doing unexpectedly well or that are comparable to oneself (Conley and Udry 2010, BinYishay and Mobarak 2015). Finally, social learning will be incomplete and diffusion will be slow if individuals cannot easily observe the experiences of their peers. In this case, information does not automatically flow from one person to another. Instead, this will only occur if both parties invest sufficient time and effort into the knowledge-sharing process.

In some cases, innovators will be keen to share information with their peers because doing so is in their own best interest. This may be due to complementarities in the number of users (technology platforms) or because of joint liability for loans. In other cases, the reverse is true, such as in the context of rival goods, contested markets, or competition for scarce resources (Banerjee et al. 2012). In many cases, however, the innovator stands to gain or lose little from spreading knowledge. Since actively engaging in the sharing of knowledge typically entails a cost, investing a lot of effort into this process is unlikely to be privately optimal. Can innovators or early adopters be incentivized to share information with their peers – internalizing learning externalities?

This important issue is first analyzed in the field by BenYishay and Mobarak (2016), who study the diffusion of agricultural innovations in rural Malawi: pit-planting and composting. They select different types of "communicators" (seed nodes) and expose them to the new technology. A random subsample of these communicators receives a performance-based incentive (a bag of seeds), where performance is based on co-villagers' knowledge about (and adoption of) the new

technologies. The main lessons from the study are that co-villagers are more likely to learn from communicators comparable to themselves (see above); communicators invest more time and effort in learning about the new technology when they are incentivized to share knowledge later; and, most importantly, providing incentives to communicators increases the flow of information and fosters knowledge levels and adoption by co-villagers. Transmission of information is not automatic, and can be manipulated via economic incentives.

The issue of incentivizing individuals to share knowledge speaks to a broader literature on intrinsic and extrinsic motives to engage in pro-social actions. The thrust of this literature is that the effect of incentives on prosocial behavior may be complex. Bénabou and Tirole (2006) develop a behavioral theory that combines altruism with concerns for social reputation and self-respect. Since material or image-related incentives create doubt about the underlying motives for which good deeds are done, they may partially or fully "crowd out" prosocial behavior. This is referred to as the "over-justification effect." If respondents receive a reward for engaging in information sharing – an act of prosocial behavior – co-villagers are unsure about the motives for sharing: was the respondent driven by altruism or desire for the reward? The former may give an impetus to somebody's status or reputation in the village, the latter presumably would not.[4] Self-image concerns suggest similar logic applies in the absence of reputational concerns (Bénabou and Tirole 2011). If respondents value conformity between actions and values or identity, then the self-image value of engaging in prosocial deeds is undermined by incentives. See, for example, Fehr and Falk (2002) or Bowles and Polonia-Reyes (2012) for extensive discussions of these issues, and related ones.

---

[4] In a lab experiment, Ariely et al. (2009) find that monetary incentives reduce the image value of pro-social behavior and the effort committed to such behavior by respondents.

On theoretical grounds, the effect of incentivizing individuals to engage in prosocial activities such as information sharing is therefore ambiguous. Ultimately it is an empirical and presumably context-specific matter whether extrinsic motives promote or discourage diffusion of knowledge. We now turn to our experiment.

3. Experimental Description

To test whether monetary incentives have a positive impact on knowledge diffusion we organized an RCT in Uganda. The experiment was conducted in conjunction with CBS PEWOSA; a social responsibility section of Central Broadcasting Services (CBS) radio, affiliated with the Buganda kingdom. CBS-PEWOSA aims to facilitate the formation of homogeneous self-help groups of $15 - 30$ members in communities in the Kingdom, and then to empower these groups with skills transfer programs, income-generating activities, food security projects, and savings programs. CBS-PEWOSA has proven able to engage effectively with a large number of communities. Their *modus operandi*, via self-formed groups, creates a useful context for our study as it provides a natural reference group of peers to study the diffusion of knowledge.

Our RCT involved two survey waves. Baseline data were collected in October 2014, when we randomly selected 40 groups to enroll in the experiment (out of a sample frame of 153 groups partnering with CBS-PEWOSA). We randomly assigned 20 of these groups to the incentive treatment (outlined below), and the remaining 20 groups to the treatment arm with the conventional training. From each group we randomly selected several members to participate in a financial literacy training. Following CBS-PEWOSA practice, we used a training ratio of 4:1 (rounding them to the nearest integer) so that we would train 6 members out of a group of 22 members. In total, we trained 266 respondents, of which 132 belonged to the incentive treatment arm.

Respondents were informed about their treatment status *before* the training began, so we leave open the possibility that treated beneficiaries will work harder during the training to become more effective knowledge communicators after the training. To incentivize diffusion, we promised participants in the treatment arm they would receive a payment of UGS 35,000 (approximately USD 10) in case they managed to share some of the training content with their (untrained) CBS-PEWOSA group members. Specifically, a participant qualified for the payment in case a randomly selected group member (i) passed a financial literacy test, and (ii) identified by a particular participant as his/her primary source of information (as the communicator). We did not inform training participants about the number of CBS-PEWOSA group members that would be tested, nor about the content of the test or the relevant knowledge threshold. Henceforth we will refer to group members who did not participate in the training themselves as "other group members" or untrained members.

The financial literacy training was conducted in January 2015 by CBS-PEWOSA field officers using the CBS-PEWOSA financial literacy manual. The training consisted of six sessions, lasting from 9:00 am to 3:00 pm (with a one-hour lunch break). The training covered basic topics such as keeping financial records, budgeting, savings, and loan management. An outline of the contents of the training sessions is provided in Appendix 1. After the training, participants in both experimental arms took a financial literacy test to gauge knowledge levels (the test was based on Sayinzoga et al. (2015) and Lusardi and Mitchell (2007), and is included in Appendix 2). We construct a knowledge index score by awarding 1 point to correct answers, ½ point to partially correct answers, and 0 points to wrong answers.[5] All participants were encouraged to share the learned knowledge with other members of their CBS-PEWOSA group, and were informed that we

---

[5] Grading the tests was done blindly—without knowledge of the treatment arm to which the respondent belonged.

would revisit the CBS-PEWOSA group after 10 months to measure the extent to which knowledge-sharing had actually occurred.

Some 10 months after the training, in October 2015, we revisited the 40 CBS-PEWOSA groups, and organized a follow-up survey among a random subsample of untrained members. For this purpose we tried to randomly select 10 members per group, and in total 394 untrained members participated in the second wave of the study. Of these other group members, 200 were from groups with incentivized peers and 194 from groups with non-incentivized peers (as we failed, for logistical reasons, to engage 6 members from two CBS-PEWOSA groups: 3 members from each group from the control arm). During this survey wave we collected data on demographics as well as the level of financial literacy. To measure knowledge levels we used the same test as we used before to measure knowledge levels of the trained individuals. We also asked untrained group members to identify the person who shared training content with them. If the untrained member passed the test, the payment was provided to the trained peer identified as the individual engaged in knowledge diffusion. We did not receive complaints from trained group members about the payment stage, suggesting that untrained group members correctly identified the individuals engaged in sharing information with them. We paid the performance fee to 47% of the incentivized group members.

Finally, at the endline we also collected financial knowledge data among members of other groups that did *not* participate in either of the treatment arms. Specifically, we randomly visited 10 groups that did not participate in the training intervention, and surveyed 10 random members per self-help group to assess their financial knowledge. Data from this control group provides the benchmark knowledge level against which knowledge gains and the cost-effectiveness of the training and incentive interventions will be assessed.

4. Data and Identification Strategy

In Tables A1 and A2 we summarize basic demographic information of the trained and untrained group members, distinguishing between respondents from incentivized, non-incentivized and control groups. There are no statistically significant differences between the groups, except for religious affiliation (which presumably reflects chance). On average, respondents are less than 40 years old, and the majority of them are married, employed in the private sector, and have completed lower secondary school.[6] We include controls in some specifications to increase the precision of our regression estimates.

<< Insert Table A1 and A2 about here >>

Turning to analysis, we first test whether the provision of incentives affects the effort that selected respondents invest in the training, and compare the financial literacy test scores of (trained) respondents across the two treatment groups. Specifically, we first regress the index score of trained respondent i ($i=1,\ldots,7$) in group j ($j=1,\ldots,40$) on the incentive dummy D_j and vectors of individual controls and group variables; X_{ij} and Z_j respectively:

$$Score_{ij} = \alpha + \beta D_j + \delta \mathbf{X}_{ij} + \gamma \mathbf{Z}_j + \varepsilon_{ij} \tag{1}$$

If respondents engage more intensively with the training content when they are incentivized to share knowledge, then we will find β>0. Following BenYishay and Mobarak (2016), we speculated incentivized respondents may work harder because they view the training as an investment opportunity. We use OLS to estimate model (1) and cluster standard errors at the group level. To account for the censored nature of our dependent variable we also estimate Tobit models, and to

---

[6] In Appendix 3 we provide an additional balance test, and demonstrate that respondents of the control group have the same characteristics as members of the conventional treatment arm.

account for the ordinal nature of our dependent variable (index scores taking values 0,...,7) we also estimate ordered probit models.

Next, we turn to our main research questions and use the endline data to test whether incentives affect knowledge diffusion. For this analysis we include the individuals from the control group. We regress the index score of untrained group member k ($k=1,\ldots,10$) in group z ($z=1,\ldots,50$) on the same variables as above:

$$Score_{kz} = \alpha + \beta_1 D_{1z} + \beta_2 D_{2z} + \delta X_{kz} + \gamma Z_z + \tag{2}$$

where D_1 is a dummy taking value one for members of *any* treatment group, and D_2 is a dummy taking the value one for members of the incentive group (so D_2 identifies a subgroup of D_1). Members of the control group are the omitted category. Estimated coefficient β_1 captures the spillover effect of the conventional training intervention, and coefficient β_2 captures the *additional* effect of incentivizing group members to share knowledge (so that the total spillover effect for the incentivized group amounts to $\beta_1+\beta_2$). As robustness tests we again estimate Tobit and ordered Probit models.

Finally, we try to probe the knowledge diffusion process in a bit more depth. Group members are free to approach each other and invest time in either teaching the other, or learning from the other. What sort of "matching" occurs in the setting we study? We are especially interested in establishing whether social proximity fosters diffusion, and therefore ask whether assortative matching occurs in the experiment. To probe this question we assess the extent to which peer-teaching occurs along certain demographic lines, and ask whether incentivizing trained respondents affects their propensity to teach peers that with whom they share fewer characteristics.

The characteristics we consider are age (young versus old), gender, education level, and tribal affiliation.

5. Empirical Results

5.1 Incentives and accumulation of knowledge: effort during the training

We first ask whether the promise of performance-based fees affects the effort of respondents during the training. This would be consistent with the finding of BenYishay and Mobarak, who documented that incentivized farmers are more likely to adopt the innovation themselves. To explore whether performance-based incentives affect effort during the training, we compare knowledge scores of trained respondents in the incentive treatment and conventional training arm. These data were collected shortly after finalizing the training so should only reflect the effect of the incentive on accumulation of knowledge. Regression results of model (1) are reported in Table 2.

<< Insert Table 2 about here>>

In columns (1-3) we present the results of OLS models, in columns (4-6) we present results based on the Tobit estimator, and in columns (7-9) we use the ordered probit estimator. Across all models we first consider a parsimonious specification, and then estimate models including vectors of controls (respondent and group variables, respectively).

Across all nine models we find positive coefficients associated with the incentive dummy, and in all models these coefficients are significantly different from zero at the 1% level. The estimated coefficient is stable across specifications, which is of course what we would expect (given that, by design, treatment status is uncorrelated with individual or group characteristics). These models reveal that the promise of a performance-based incentive increases the effort

(attention) of training participants to grasp the training content. The impact of the fee on effort is also economically meaningful: OLS and Tobit estimates of the parsimonious models suggest that incentives increase post-training test scores by about 30%. Not surprisingly, perhaps, we also find that better-educated respondents achieve higher knowledge scores.

5.2 Incentives and diffusion of knowledge

We next analyze how incentives affect the diffusion of knowledge by comparing financial knowledge levels of "other group members" across the experimental arms and the control arm. The reduced form models we estimate capture the joint impact of incentives on effort of trained respondents *during* the training (discussed above) as well as additional effort *after* the training – sharing the content of the training with other group members. Before presenting our results in a regression framework we first demonstrate histograms displaying the number of other group members that achieves a certain test score, split out between untrained group members from incentivized, non-incentivized and the control groups.

<< Insert Figure 1 about here >>

The figures suggest that other members from groups with incentivized respondents (Panel A) tend to answer more questions correctly. For example, the number of other group members scoring 6.5/7 (or 7/7) equals 16 (18) from the incentivized group, and only 9 (12) from the non-incentivized group. The number of other group members scoring 2/7 or worse equals 39 for the incentivized group, and 60 for the non-incentivized group. These patterns in the data are also evident from the regression analysis. Estimating model (2) provides the following results:

<< Insert Table 3 about here >>

Across all three sets of outcomes (OLS, Tobit, ordered probit), we again consider a parsimonious specification, and then estimate more "complete models" including vectors of controls, X_{ij} and Z_j. The first thing to observe is that the Training Dummy D_1, associated with the two treatment arms, is consistently positive and significant across all specifications. We document significant "spillover" of knowledge within self-help groups, and according to the parsimonious OLS and Tobit specifications it is the case that group members achieve knowledge scores that are some 15% higher than those of their peers in control groups. Indeed, it appears as if the sharing of knowledge within self-help groups is almost complete. According to the parsimonious OLS model untrained members from the conventional training arm achieve knowledge scores of (43.071+6.450=) 49.521, which is statistically identical to the knowledge level of trained group members (50.906, or the constant in Table 2).

The second thing to observe is that, across all nine models, we find positive coefficients associated with the incentive dummy. Moreover, these coefficients are significantly different from zero, albeit only at the 10% level in most specifications. This, we believe, is our main result. It indicates that untrained members in groups with incentivized respondents accumulate more financial knowledge than untrained members from the conventional training group (and, of course, much more than members from the control group). This difference in learning across experimental arms is relatively large. When comparing the incentive effect to the knowledge level of the conventional training group, our parsimonious OLS and Tobit estimates reveal that incentives increase knowledge spillovers by some 15%.[7] As before, we find that knowledge sharing within the subsample of incentivized group members is fairly complete: the knowledge scores obtained

---

[7] The Wald test on the coefficients in columns 1-3, and columns 4-6 indicate that the explanatory variables have different effects on the dependent variables. This is evident from the F-statistics which are significant.

by other (untrained) group members only lag slightly behind the scores of the trained group members. Specifically, from Table 3 we learn that the average untrained group member has a knowledge score of 57.1 (43.071+7.586+6.450), which should be compared to the average score by trained group members (50.906+15.652=66,558, from column 1 in Table 2). In other words, untrained group members achieves scores that, on average, are no less than 85% of the scores of trained individuals. We conjecture that slight differences in the extent to which sharing occurs across the two treatment arms are due to increasing marginal costs (or diminishing marginal returns) to teaching and learning within self-help groups.

Next, turn to the other covariates. Not surprisingly, we again find that more educated group members tend to perform better on the knowledge test. We also find that the age of the respondent matters – young respondents appear to score better, but this effect is not very large. Interestingly, group size does not matter. This presumably reflects that we have selected a fixed number of other group members for the endline survey, which implies that the probability of picking any specific untrained group member goes down as the group gets larger. From the perspective of trained group members, this reduces the expected payoff of investing time and effort in training specific individuals.[8]

5.2 Who learns from whom?

We asked untrained group members to identify the individual who shared training content with them (if anybody). We now ask whether assortative matching occurs in the self-help groups, or whether individuals are more likely to learn from group members with similar demographic characteristics. In Table 4 we report the extent to which matching on such variables occurs. For

---

[8] Observe that group ties within larger groups may be weaker, so that (on average) the altruistic incentive to train fellow group members may also be lower. This will be the case in both treatment arms.

each untrained individual we create four dummy variables capturing whether the group member that "trained" her shared the same age, gender, education level, and tribal affiliation. We then average the value of these binary variables across respondents to obtain a (treatment arm specific) measure of assortative matching intensity. We compare this actual intensity level to the predicted level of matching that would occur if untrained and trained group members matched randomly within the self-help group.

<< Insert Table 4 about here >>

Most of the social learning occurs for pairs with the same gender – this is the case for 67% of the matches. However, this degree of assortative matching is not statistically different from the degree of matching that would occur if group members are randomly matched. Similarly, there is no evidence of assortative matching based on education level or tribal affiliation. The single demographic variable for which actual and random matching intensity is different is age, and there the opposite of assortative matching appears to occur. The old members learn more from the young. Interestingly, the same patterns emerge in the data for the incentivized and the non-incentivized treatment arm. We do not observe that trained individuals single out fellow group members who are more like themselves (i.e., more assortative matching), nor that they become less "picky" about whom to spend time with (less assortative matching). If we regress the measured assortative matching intensity on an incentive dummy we consistently find there is no significant correlation between matching intensity and the treatment dummy (results not shown, but available on request). To some extent this is an artefact of the social context within which we study social learning. Self-help groups are composed of randomly selected villagers, who have self-selected into the group. Social capital levels within the group are likely to be high, and we expect considerable willingness to help fellow group members. This also implies the extent of social

learning in these groups may be unrepresentative of the intensity of knowledge spillovers occurring in settings where individuals cannot choose their peers.

5.4 Cost effectiveness of incentivizing diffusion

Does it make economic sense to incentivize trained individuals to share knowledge with their peers? A full-blown cost-benefit analysis is beyond the scope of the current paper, and requires a comparison of the costs of training and incentives to economic gains for beneficiaries – data that are currently unavailable. However, it is possible to compare the cost of raising knowledge scores across treatment arms. That is, we can use our survey data to compute the cost effectiveness of the conventional training approach, and the alternative modality that includes incentives for knowledge sharing.

Consider an "average" self-help group in our sample, consisting of 24 group members. Of this self-help group, 6 members are invited to participate in the training, and the remaining 18 members remain untrained (by CBS-PEWOSA). If this group is allocated to a conventional training program, the estimated implementation cost of the training amount to UGS 1.1 million. (according to CBS-PEWOSA data). If, instead, the group is assigned to an incentive program, the total training costs (now including performance fees) amount to UGS 1.2 million.[9] Does the additional expenditure of UGS 100,000 decrease the per-unit cost of knowledge transfer?

This question is readily addressed by our data. The conventional training arm achieves the following gains in terms of increased knowledge scores: 6 trained members gain an additional 7.835 points per member (compare the constant terms in column 1 of Table 2 and Table 3), and 18 untrained members benefit from an increase in 6.450 knowledge points. The total gain in

---

[9] Recall that in the incentive group, 47% of the trained individuals receive a payment of UGS 35,000.

knowledge, according to our estimates, is then equal to 163.1 index points (or $(6 \times 7.835) + (18 \times 6.450)$). The average cost per unit of knowledge gain amount to UGS 6744.

We can do the same exercise for the training modality that includes incentives for knowledge sharing. According to our estimates, the same training now produces a total increase in knowledge equal to 393.5 index points, with an associated average per-unit cost of only UGS 3,049. In words, providing incentives for diffusion approximately cuts the average costs of knowledge transfer in half. It therefore appears like an attractive opportunity for NGOs or governments with binding budget constraints – promoting diffusion is less expensive than upscaling teaching interventions. Observe that our performance fee of UGS 35,000 was chosen in a rather arbitrary fashion, so additional efficiency gains may be possible by optimizing the amount of the reward.

6. Discussion and Conclusions

Diffusion of knowledge and innovations often occur at rates that appear "too low." As a result, advantageous behaviors and production techniques may remain limited to pockets of the overall population, with adverse effects for (economic) outcomes. Limited social learning also undermines the cost effectiveness of development interventions, possibly eroding the economic rationale for such interventions. It is important to improve our understanding of how knowledge spreads in target populations to enhance the efficiency and effectiveness of trainings and projects.

In this paper we examine whether the diffusion of knowledge can be promoted by the provision of (monetary) incentives. We study social learning in the context of NGO-founded self-help groups in which individuals can self-select. Endogenous membership presumably implies these groups have high levels of social cohesion and social capital, or provide a setting where

social learning is given the best chance to succeed. Care must be taken when extending the main insights of this study to other contexts such as villages where membership is (more) exogenous and inter-person ties are looser.

Our first result is that we find evidence of knowledge diffusion even in the absence of incentives. Indeed, we find that nearly all the knowledge gained by (randomly selected) group members spills over to peers. This is perhaps an artefact of the social context, mentioned above. Our second result is that incentivizing individuals to share knowledge with their group members encourages these individuals to study harder and accumulate more knowledge during the trainings. The increase in knowledge due to the trainings for members of the incentivized group is about one-third of the gain for unincentivized individuals. Our third and main result is that incentivizing individuals has a large effect on social learning. The knowledge spilling over to "other" group members in the incentivized treatment arm is twice the size of the spillover in the unincentivized group. Indeed, the magnitude of the spillover gain implies that the provision of incentives is a cost-effective approach to promoting knowledge diffusion.

While it is comforting to observe that social learning can leverage the effectiveness of training interventions, and that the extent of social learning can be manipulated by incentives, it is evident that major challenges remain for practitioners seeking to put the lessons from this analysis to practice. Specifically, there are many cases and contexts where knowledge diffusion should not stop after a single round of social learning. Individuals benefitting from the knowledge imparted on them by their peers should, in turn, share this knowledge with other villagers – and so on, until the entire target population has been reached. Affecting the behavior of "downstream" beneficiaries via individual incentives may be far from straightforward. An alternative approach may be providing incentives at the village level – the promise of specific local public goods.

However, this introduces free rider issues. Exploring efficient and effective designs at the village level is left for future research.

References

Agarwal, R., Echambadi, R., Franco, A. M., and Sarkar, M. B. (2004). Knowledge transfer through inheritance: Spin-out generation, development, and survival. *Academy of Management journal, 47*(4), 501-522.

Alavi, M., and Leidner, D. E. (1999). Knowledge management systems: issues, challenges, and benefits. *Communications of the AIS, 1*(2es), 1.

Alavi, M., and Leidner, D. (2001). Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS quarterly*, 107-136.

Argote, L., and Ingram, P. (2000). Knowledge transfer: A basis for competitive advantage in firms. *Organizational behavior and human decision processes, 82*(1), 150-169.

Ariely, D., Bracha, A., and Meier, S. (2009). Doing good or doing well? Image motivation and monetary incentives in behaving prosocially. *American economic review, 99*(1), 544-555.

Bénabou, R., and Tirole, J. (2006). Incentives and prosocial behavior. *The American Economic Review*, 1652-1678.

Benabou, R., and Tirole, J. (2011). Identity, morals, and taboos: Beliefs as assets. *The Quarterly Journal of Economics, 126*, 805-855

BenYishay, A., and Mobarak, A. M. (2014). Social learning and communication: National Bureau of Economic Research.

Berge, L. I. O., Bjorvatn, K. and Tungodden, B. (2014). Human and financial capital for microenterprise development: Evidence from a field and lab experiment. *Management Science*, In Press.

Berge, L.I.O., K. Bjorvatn, K.S. Juniwaty and B. Tungodden (2012). Business training in Tanzania"From research-driven experiment to local implementation. *Journal of African Economies* 21(5): 808-827

Bjorvatn, K. and Tungodden, B. (2010). Teaching business in Tanzania: Evaluating participation and performance. *Journal of the European Economic Association, 8*(2/3), 561-570.

Breza, E. (2015). Field Experiments, Social Networks, and Development. Columbia Business School. Discussion Paper

Bruhn, M. and Zia, B. (2013). Stimulating managerial capital in emerging markets: The impact of business training for young entrepreneurs. *Journal of Development Effectiveness, 5*(2), 232-266.

Bruhn, M., Karlan, D. and Schoar, A. (2010). What capital is missing in developing countries? *The American Economic Review,* 629-633.

Bruhn, M., G. Lara Ibarra and D. McKenzie (2013) *Why is voluntary financial education so unpopular? Experimental evidence from Mexico*, The World Bank, Development Research Group.

Björkman, I., Barner-Rasmussen, W., and Li, L. (2004). Managing knowledge transfer in MNCs: The impact of headquarters control mechanisms. *Journal of international business studies, 35*(5), 443-455.

Bowles, S. and S. Polonia-Reyes (2012). Economic Incentives and Social Preferences: Substitutes or Complements? *Journal of Economic Literature* 50(2): 368-425

Cole, S., T. Sampson and B. Zia (2011). 'Prices or knowledge? What drives demand for financial services in emerging markets?', *The Journal of Finance*, vol. **66**(**6**), pp. 1933-1967

Cummings, J. L., and Teng, B.-S. (2003). Transferring RandD knowledge: the key factors affecting knowledge transfer success. *Journal of Engineering and technology management, 20*(1), 39-68.

Drexler, A., Fischer, G. and Schoar, A. (2014). Keeping it simple: Financial literacy training and rule of thumbs: Evidence from a field Experiment. *American Economic Journal: Applied Economics, 6*(2) 1-31

Ernst, D., and Kim, L. (2002). Global production networks, knowledge diffusion, and local capability formation. *Research policy, 31*(8), 1417-1429.

Fehr, E., and Falk, A. (2002). Psychological foundations of incentives. *European Economic Review, 46*(4), 687-724

Foster, A.D. and M. Rosenzweig (2010). Microeconomics of technology adoption. *Annual Review of Economics* 2: 395-424

Giné, X. and Mansuri, G. (2014). Money or ideas? A field experiment on constraints to entrepreneurship in rural Pakistan. *Policy Research Working Paper 6959. Washington DC: World Bank.*

Hendriks, P. (1999). Why share knowledge? The influence of ICT on the motivation for knowledge sharing. *Knowledge and process management, 6*(2), 91.

Inkpen, A. C., and Tsang, E. W. (2005). Social capital, networks, and knowledge transfer. *Academy of management review, 30*(1), 146-165.

Karlan, D. and Valdivia, M. (2011). Teaching entrepreneurship: Impact of business training on microfinance clients and institutions. *Review of Economics and Statistics, 93*(2), 510-527.

Koizumi, T., and Kopecky, K. J. (1977). Economic growth, capital movements and the international transfer of technical knowledge. *Journal of International Economics, 7*(1), 45-65.

Landerretche, O. M. and C. Martínez (2013). 'Voluntary savings, financial behavior, and pension finance literacy: evidence from Chile', *Journal of Pension Economics and Finance*, vol. **12**(**03**), pp. 251-297.

Lucas, L. M., and Ogilvie, D. (2006). Things are not always what they seem: How reputations, culture, and incentives influence knowledge transfer. *The Learning Organization, 13*(1), 7-24.

Lusardi, A., and Mitchell, O. S. (2007). Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth. *Journal of monetary Economics, 54*(1), 205-224.

Lusardi, A. and O. S. Mitchell (2008). 'Planning and financial literacy: How do women fare?', *American Economic Review: Papers and Proceedings*, vol. **98**(**2**), pp. 413–417.

McKenzie, D. and Woodruff, C. (2014). What are we learning from business training and entrepreneurship evaluations around the developing world? *The World Bank Research Observer, 29*(1), 48-82

Mowery, D. C., Oxley, J. E., and Silverman, B. S. (1996). Strategic alliances and interfirm knowledge transfer. *Strategic management journal, 17*(S2), 77-91.

Munshi, K. (2004). Social Learning in a Heterogeneous Population: Technology Diffusion in the Indian Green Revolution. *Journal of Development Economics* 73: 185-213

Osterloh, M., and Frey, B. S. (2000). Motivation, knowledge transfer, and organizational forms. *Organization science, 11*(5), 538-550.

Reagans, R., and McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative science quarterly, 48*(2), 240-267.

Rhodes, J., Hung, R., Lok, P., Ya-Hui Lien, B., and Wu, C.-M. (2008). Factors influencing organizational knowledge transfer: implication for corporate performance. *Journal of knowledge management, 12*(3), 84-100.

Sayinzoga, A., Bulte, E. H., and Lensink, R. (2015). Financial Literacy and Financial Behaviour: Experimental Evidence from Rural Rwanda. *The Economic Journal*, n/a-n/a. doi: 10.1111/ecoj.12217

Sjöholm, F. (1996). International transfer of knowledge: the role of international trade and geographic proximity. *Weltwirtschaftliches Archiv, 132*(1), 97-115.

Sorenson, O., and Fleming, L. (2004). Science and the diffusion of knowledge. *Research policy, 33*(10), 1615-1634.

Szulanski, G. (2000). The process of knowledge transfer: A diachronic analysis of stickiness. *Organizational behavior and human decision processes, 82*(1), 9-27.

Szulanski, G. (2002). *Sticky knowledge: Barriers to knowing in the firm*: Sage.

Tustin, D. H. (2010). 'An impact assessment of a prototype financial literacy flagship programme in a rural South African setting', *African Journal of Business Management*, vol. **4(9)**, pp. 1894-1902.

Appendix 1: Financial Literacy Training Manual for CBS-PEWOSA

CBS-PEWOSA financial literacy training manual is comprised of the topics

(1) Understanding financial literacy.

(2) Taking financial records.

(3) Budgeting.

(4) Saving as a culture.

(5) Loan management.

Topic 1 entitled "Understanding financial literacy" focuses on imparting knowledge and skills on members concerning the use of financial resources productively. That is, it encourages members to use money wisely and calls on members to have discipline in spending such that money becomes "a friend" than an "enemy". Further, it covers aspects of inflation and its associated effects plus the need of valuing money regardless of which face value—illustrations including examples are used to explain why money should be valued.

Topic 2 entitled "Taking financial records" emphasizes the need to take records on daily earnings, daily expenditures and daily savings. It also teaches members to aggregate their daily records at week level and month level. Members are taught to compare their earnings, expenses and savings at all levels (daily, weekly and monthly) to track for the differences/changes. Then, members are encouraged to find reasons for such differences. Thereafter, finds solutions if the records are not moving the intended way.

Topic 3 which is entitled "Budgeting" focuses on understanding the meaning and the need for budgeting, when and how to make a simple budget, categorizing of the household needs (starting from the most pressing needs) and how to stay within your budget.

Topic 4, "Saving as a culture" takes participants through the need for saving and explains how saving should be a culture to everyone. It also covers the different ways of saving which range from non-cash savings like assets to cash savings. It further compares the advantages and disadvantages the informal saving schemes like keeping money in the house to semi-formal savings like keeping money in self-help groups and then to formal savings like keeping money in banking institutions. This topics also covers some aspects of investment like why invest, how to identify a better investment option, how to manage your investment venture, how to help it grow, customer care, customer attraction and customer retention as major tools of expanding any investment venture.

Topic 5, "Loan management" starts with explaining the various terms used in borrowing. These terms include loan size, interest rate (members are trained on how to compute simple interest rate and how to compute interest on decreasing balances), fees, grace period, repayment schedule etc. The topic also compares the advantages and disadvantages of using borrowed funds vs using own funds. It furthers looks at the risks of taking a loan, how to prepare for a loan, loan sources, what to consider before taking a loan from source and how to prepare for repayment.

Appendix 2: Test Questions for Knowledge Diffusion.

(1) Suppose you made a stock some goods today at a cost of shs. 405000 and with a transport charge of shs. 35000. You pay people who help you to load the goods a free of shs. 15000. If you sale those goods at a price of shs. 515000, what is your profit? **Answer: 60000.**

(2) What do you understand by preparing a daily budget in a home. **Answer: Preparing a document/instrument that shows daily earnings and expenditure within the home.**

(3) Suppose you receive a loan worth 1,000,000/=at an interest rate of 5% per month. If its repayment period is six months, what could be your monthly interest payment? **Answer: 50000/=**

(4) From (2) above, what could be the total repayment amount (principle+interest) at maturity? **Answer: 1,300,000/=**

(5) Suppose you have 1,00,000/= in your savings account and the interest rate paid on your savings is 10% per month and you never make any withdraw. After six months, how much would you have in your account? **Answer: 160,000/=**

(6) Assume that interest rate on your savings account is 5% per year and inflation is 10% per year. After one year, how much would you be able to buy with the money on your account? **Answer: Less than today**

(7) Assuming you are interested in borrowing 1000,000 Uganda shillings today for investment and you get information that inflation stands at 10% but it is projected to be at 17% in the next four months. When would you take the loan? **Answer: Today.**

Appendix 3 – Detailed Variables Definition and Additional Balance Test

Age (Female): defines the age of female respondents in complete years.

Age (Male): defines the age of male respondents in complete years.

Married/Engaged: respondent's marital status with married or engaged = 1, zero otherwise.

Number of children: children owned by the respondent.

Education : highest grade/class completed by the respondent.

Religion (Christian): respondents whose religious affiliation is christianity.

Tribe (Muganda): respondents who are Baganda by tribe.

Land ownership (HH): households which own land.

The Tables A1 and A2 below test present the summary statistics for the trained and untrained members respectively.

Table A1: Summary of the data for the trained members

	Incentivized group	N	Non-Incentivized group	N	Differences	P-values
Age	37.515	132	37.649	134	0.134	0.763
Gender (male)	0.205	132	0.209	134	0.004	0.930
Married/Engaged	0.621	132	0.619	134	-0.002	0.976
Education	3.258	132	3.269	134	0.011	0.897
Tribe (Muganda)	0.818	132	0.858	134	0.040	0.377

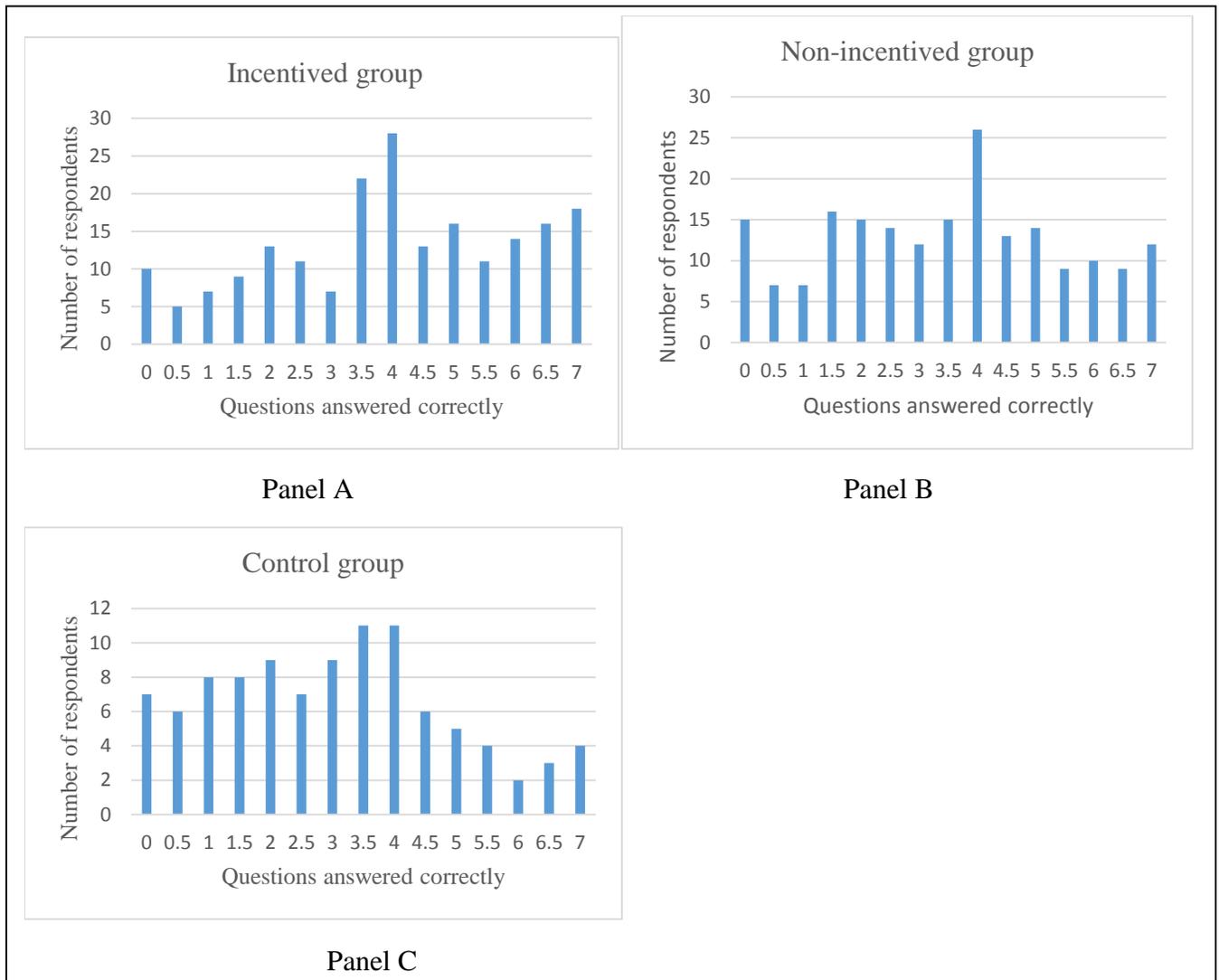**Tables and Figures**

Panel A

Panel B

Panel C

Figure 1: Respondents' scores from the test questions in the incentivized, Non-incentivized and control group

Table A2: Summary of data for the untrained members: incentivized, non-incentivized and control groups

	Incentivized group N = 200	Non-Incentivized Group N = 194	Control N = 100	P-values 1=2	P-values 1=3	P-values 2=3
Age	37.000	38.165	37.660	0.372	0.666	0.734
Gender (male)	0.235	0.237	0.220	0.961	0.772	0.743
Married/Engaged	0.615	0.686	0.710	0.143	0.105	0.668
Number of children	3.555	3.943	3.990	0.138	0.182	0.883
Education	3.295	3.046	3.200	0.126	0.624	0.437
Religion (Christians)	0.650	0.763	0.710	0.014	0.299	0.326
Tribe (Muganda)	0.810	0.825	0.850	0.706	0.394	0.584
Land ownership (HH)	0.600	0.655	0.640	0.263	0.504	0.804

Table 2: Incentives and knowledge accumulation of trained group members

	Scores (percent)								
	OLS			Tobit			Ordered probit		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Incentive dummy	15.652*** (2.542)	15.692*** (2.536)	15.753*** (2.536)	15.759*** (2.533)	15.793*** (2.519)	15.851*** (2.510)	0.121*** (0.026)	0.128*** (0.027)	0.129*** (0.027)
Age (Trained)		-0.194 (0.366)	-0.184 (0.373)		-0.192 (0.368)	-0.181 (0.373)		-0.0005 (0.003)	-0.0004 (0.003)
Education (Trained)		5.957*** (1.570)	5.901*** (1.628)		5.935*** (1.576)	5.877*** (1.629)		0.055*** (0.015)	0.055*** (.01543)
Group size			0.157 (0.413)			0.146 (0.408)			0.0009 (0.003)
Group age			0.341 (1.438)			0.372 (1.433)			0.003 (0.011)
Constant	50.906*** (1.763)	38.756*** (13.257)	32.970 (20.057)	50.800*** (1.753)	38.625*** (13.421)	33.011 (20.011)			
N	266	266	266	266	266	266	266	266	266
R-Squared	0.120	0.155	0.155						
Pseudo-R^2				0.0141	0.0185	0.0186	0.0358	0.049	0.049

Notes: Columns 1-3 report results of an ordinary least squares regression. Columns 4-6 report results of a Tobit regression. Columns 7-9 report ordered probit marginal effects. Scores in models $1-6$ are calculated as $score_{ij}/7*100$, and in columns $7-9$ we construct ordered categories for (rounded) scores. Clustered standard errors at group level are reported in the brackets. ***$p<0.01$ ***$p<0.05$ and *$p<0.1$.

Table 3: Incentives, training and knowledge diffusion of untrained group members

	Scores (Percent)								
	OLS			**Tobit**			**Ordered probit**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Training dummy	6.450**	8.058***	6.126**	6.425*	8.226***	6.001*	0.024*	0.044***	0.034**
	(3.171)	(2.665)	(2.958)	(3.418)	(2.853)	(3.134)	(0.012)	(0.015)	(0.017)
Training + incentives dummy	7.586**	4.867*	4.215*	7.982**	2.853*	4.460*	0.026*	0.026*	0.023*
	(3.597)	(2.624)	(2.506)	(3.845)	(2.766)	(2.602)	(0.014)	(0.016)	(0.015)
Age (Untrained)		-0.335***	-0.328***		-0.396***	-0.387***		-0.002***	-0.002***
		(0.084)	(0.083)		(0.095)	(0.093)		(0.001)	(0.001)
Education (Untrained)		9.367***	9.403***		9.736***	9.781***		0.051***	0.051***
		(0.655)	(0.651)		(0.689)	(0.684)		(0.008)	(0.008)
Group size			-0.679*			-0.710*			-0.004**
			(0.352)			(0.374)			(0.002)
Group age			-1.492			-1.761			-0.008
			(1.367)			(1.430)			(0.008)
Constant	43.071***	25.722***	51.703***	42.124***	25.826***	53.865***			
	(1.720)	(4.317)	(11.054)	(1.833)	(4.580)	(11.968)			
N	494	494	494	494	494	494	494	494	494
R-Squared	0.035	0.389	0.394						
Pseudo-R^2				0.004	0.053	0.054	0.009	0.126	0.129

Notes: Columns 1-3 report results of an ordinary least squares regression. Columns 4-6 report results of a Tobit regression. Columns 7-9 report ordered probit marginal effects. Scores in models $1-6$ are calculated as $score_{ij}/7 * 100$ and in columns $7-9$ we construct ordered categories for the scores. The Training dummy takes a value of 1 if the respondent belongs to either of the trained groups, and the Training + Incentives dummy takes a value of 1 if the respondent belongs to a group that was trained and incentivized. Clustered standard errors at group level are reported in the brackets. ***$p < 0.01$ ***$p<0.05$ and *$p < 0.1$

Table 4: Actual matches vs possible matches between the trainers and the untrained.

Matches	Incentivized			Non-incentivized			Pooled		
	Actual mean	Possible mean	P-value	Actual mean	Possible mean	P-value	Actual mean	Possible mean	P-value
Same sex	0.670	0.677	0.731	0.608	0.588	0.191	0.640	0.633	0.591
Same age (Young)	0.380	0.535	0.000	0.335	0.497	0.000	0.358	0.516	0.000
Same age (Old)	0.170	0.535	0.000	0.211	0.497	0.000	0.190	0.516	0.000
Same education	0.210	0.215	0.818	0.237	0.212	0.241	0.223	0.213	0.504
Same tribe	0.715	0.678	0.115	0.680	0.669	0.658	0.698	0.674	0.151

Note: respondents are classified as "young" if they are younger than the average respondent (38 years).