Moral Hazard Incentives under Formal Insurance and Informal Insurance:

Evidence from a Framed Field Experiment

Abstract

In this paper we explore moral hazard incentives associated with formal and informal insurance. We develop a theoretical model of risky effort that incorporates formal insurance and risk sharing, and use a framed field experiment in rural Uganda to test model predictions. Consistent with the theory, we find evidence of moral hazard under informal insurance. We however do not find evidence for moral hazard under formal insurance in our experiment. We propose lack of familiarity with formal insurance products may cause irrational behaviour. Our findings are consistent with findings from earlier studies which suggest that a lack of familiarity impedes the development of formal insurance markets.
1 Introduction

Variability in weather conditions is a major source of risk for smallholder farmers in poor regions of the world. Unexpected shocks, such as illnesses of family members and unfavourable weather conditions, translate into lower returns to capital, effort and time of agricultural households. This may cause shortfalls in household income and consumption (De Weerdt & Dercon, 2006; Karlan, Osei, Osei-Akoto, & Udry, 2014; Morduch, 1999a).

To mitigate shortfalls in income and in effort to smooth consumption, many rural households rely on informal insurance institutions. This includes as in-kind or cash transfers from households in good states to those in bad states, for example among kin members and socially-close households (Arnott & Stiglitz, 1991; Morduch, 1999a). However, informal insurance institutions usually provides imperfect coverage (De Weerdt & Dercon, 2006), and may impede own productive investments (Grimm et al., 2016).

Formal insurance products may be used by rural households to mitigate shortfalls in income. Index insurance is based on verifiable data, for instance a weather (rain) index, making incentive problems inapplicable and reducing transaction costs (Dercon et al., 2014). Indemnity insurance takes the form of individual crop indemnity designed for smallholder households, and incentive problems and transaction costs are bidding in this case. Formal insurance products have more recently been promoted in poor rural regions of the world. Recent studies also find a positive impact of the uptake of formal insurance products on farm investment and income (Karlan et al., 2014; Vargas & Viceisza, 2012). However, the uptake of formal insurance products in rural areas of Africa is low (Ackah & Owusu, 2012; Eling et al., 2014). This may be due to different reasons, including information asymmetries, prohibitive
transaction costs, lack of trust, or lack of knowledge about the insurance product (Ackah & Owusu, 2012; J. Cai & Song, 2017; Cole et al., 2011; Giné & Yang, 2009).

While households in poor communities use informal insurance institutions regularly, and often demonstrate a clear understanding of it, the same is not true for formal insurance products. Many households are not familiar with these products (Ackah & Owusu, 2012; Dercon, Gunning, & Zeitlin, 2011; Eling et al., 2014; Giesbert, 2012), and may not understand their implications. Survey evidence among African farmers shows that lack of knowledge limits the uptake of formal insurance products (Ackah & Owusu, 2012; Dercon et al., 2011; Giesbert, 2012). Reviews by Erev & Haruvy (2013) and Eling et al (2014) stress the relevance of awareness to uptake of formal insurance products.

In a context of asymmetric information about behaviour, economic theory predicts that moral hazard should affect agricultural decisions. Specifically, we expect insured farmers to underinvest in self-protection – both in terms of effort (time) and capital.

In this paper, we study moral hazard associated with formal insurance and informal insurance. We develop a stylized theoretical model, showing how effort of fully informed farmers should be affected by the introduction of formal and informal insurance. We compare effort supply in autarky (without any insurance coverage) with effort supply under formal and informal insurance. Comparative statistics predict that, ceteris paribus, effort should be highest in autarky, followed by informal insurance, and lowest under formal insurance. We use a framed field experiment conducted in rural Uganda to test predictions of the model. The experiment involves a risky real effort task, as well as good and bad states of the world. We analyse effort supply to mitigate risk (or moral hazard) under different treatment conditions.
Subjects playing the real effort game are randomly assigned to one of two groups: the formal insurance group and the informal insurance group. In both treatments, returns to effort are volatile, varying with the (exogenous) state of the world – good or bad. Formal insurance group members engage in the risky effort task each round with the prospect of coverage from an insurance product. They pay a fixed insurance premium, and receive a transfer when they experience a bad state. There are three sub-treatments for the formal insurance group. In the first one, the formal insurance (premium) transfer is determined by the experimenter, is fixed and of public knowledge. In the second one, each group member voluntarily chooses a formal insurance (coverage) transfer plan. In the last arm, each member plays the control treatment (autarky condition).

Each informal insurance group member is paired with another informal insurance group member and engages in the effort task, with the prospect of receiving transfers from the partner – depending on states of the world. Transfers are sent from members with good states to others with bad states. There are three sub-treatments. First, the transfer amount is fixed by the experimenter and is of public knowledge. Second, each group member voluntarily chooses how much to transfer to their partner. In the third arm each member plays the control treatment (autarky condition).

Experiment results show that with informal insurance, risky effort is lower than under autarky. This is consistent with model predictions. Contrary to model predictions however, effort with formal insurance is not statistically different from effort under autarky. These findings suggest households fail to take full advantage of insurance products. Unlike informal insurance, the “working” of formal insurance is not clear to households who lack experience with such products. When formal insurance is available to these households, they learn how to
use it. We document that subjects learn about formal insurance throughout the game, choosing higher coverage levels after experiencing low earnings due to bad states of production.

This study is organised as follows: section 2 presents related literature and a stylized model; section 3 describes experiment; section 4 gives the data description; section 5 gives the identification; section 6 presents the results; section 7 gives conclusions and discussion.

2 Conceptual framework

Principal-agent relations with outcomes contingent on unobservable action, invite moral hazard. Moral hazard is the tendency of insured individuals to under-supply self-protection, by reducing effort, time or capital investment (Hölmstrom, 1979; Mirrlees, 1999; Pauly, 1968). Moral hazard threatens efficiency (Hölmstrom, 1979; Johnson, 1977), influencing insurance costs from the perspective of the insurance company.

In this paper, insurance coverage provided by registered companies is considered formal insurance (see also Lin et al., 2014). Each period, insured individuals pay an upfront premium, and receive a payment (benefit) in periods when they suffer a bad state of production. Insured individuals are reluctant to supply effort to increase the probability of a good state of production, because they are insured from losses in the bad state. To mitigate moral hazard incentives, insurance companies offer partial insurance coverage (Arnott & Stiglitz, 1991; Ligon & Thistle, 2008; Ray, 2011).

Informal insurance institutions include cash transfers or in-kind assistance for misfortune or opportunity, exchanged amongst members within a risk sharing network (Charness & Genicot, 2009; Coate & Ravallion, 1993; Genicot & Ray, 2003; Ligon et al., 2002; Platteau, 1997). Informal institutions are not enforced by law, and benefits are typically
based on prospects in terms of reciprocity in the future. Individuals with informal insurance receive coverage by sharing output with their risk-sharing partner. Transfers generally flow from individuals in good states to members in bad states. In addition to the standard moral hazard effect mentioned above, individuals also experience a disincentive to supply effort because they are expected to share with less-fortunate partners (eroding profits of good states). Alger & Weibull (2010) and Belhaj & Deroïan (2012) model such incentives, and find that when effort is unobservable, individuals exert low effort and make lower risk sharing transfers. But stronger levels of altruism facilitate more equitable risk sharing, and higher welfare outcomes.

Our model builds on existing literature by comparing moral hazard incentives under formal and informal insurance. It follows Alger & Weibull’s (2010) characterization of optimal choices for risk averse agents under informal insurance.

We have in mind an agricultural context for two risk averse economic agents $i$ & $j \in \{1,2\}$ ($j \neq i$) producing an agricultural good for multiple years with volatile returns to their effort. Each agent chooses an effort level ($x$) that determines the returns to output. Suppose there are 2 states of the nature. A good state where output is high, $Y^H$, and a bad state where output is low ($Y^L$). Probability for high output, $p$, is increasing in agent’s effort, $p = f(x)$ such that $f'(x) > 0$, $f''(x) = 0$ and $p \in [0,1]$, $p \to 1$ as $x \to \infty$. Per year expected utility for an agent is given by:

$$EU = p(x)u(Y^H) + (1 - p(x))u(Y^L) - v(x)$$ (1)

where $u(Y)$ is the utility from consuming $Y$, $u' > 0$, $u'' < 0$, and, $v(x)$, is the cost of effort (disutility from effort), $v'(x) > 0$, and $v''(x) > 0$. We can simplify the model such that agents
can instead choose a probability for high output $p \in [0,1]$. Expected utility under autarky, without any insurance coverage, is given by:

$$EU = pu(Y^H) + (1 - p)u(Y^L) - \omega(p)$$  \hspace{1cm} (2)

where $\omega(p)$ is the cost of effort to reach probability $p$: $\omega(p) = v(f^{-1}(p))$. $\omega'(p) > 0$, $\omega''(p) > 0$. Optimal probability $p^A$ under autarky without any insurance coverage, and thereby optimal effort $x^A = f^{-1}(p^A)$ is determined by the first order condition that maximizes expected utility under autarky (2):

$$u(Y^H) - u(Y^L) = \omega'(p^A).$$  \hspace{1cm} (3)

2.1 **Compulsory formal insurance**

Now suppose that purchasing formal insurance coverage is compulsory, and that the insurance premium and coverage are fixed. Each agent pays premium $(C > 0)$\(^1\) to the insurance company, which pays each agent benefit $(B > 0)$\(^2\) when an agent receives $Y^L$ in a bad state of the nature. We assume the insurance company cannot observe effort, and agents are sure that the insurance company will not renege.

Augmenting premium cost and benefit of the compulsory formal insurance to (2), we rewrite (2). Now the expected utility under compulsory formal insurance is given by:

$$EU = pu(Y^H - C) + (1 - p)u(Y^L + B - C) - \omega(p)$$  \hspace{1cm} (4)

Optimal probability to receive high output under compulsory formal insurance, $p^I$, and optimal effort $x^I = f^{-1}(p^I)$ is determined by the first order condition maximizing (4):

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\(^1\) We consider actuarially fair insurance, $C \geq (1 - p)B$, (Chiappori et al., 2012; Dahlby, 1981; Jehle & Reny, 2000).

\(^2\) In line with reality, we consider partial insurance coverage, $Y^H - Y^L > B$. 
\[ u(Y^H - C) - u(Y^L + B - C) = \omega'(p^I) \]  

(5)

Does the agent supply more effort under autarky or partial formal insurance? To answer this we compare \( p^A \) and \( p^I \). It is evident that the marginal benefit from effort under formal insurance is smaller than the marginal benefit under autarky, \( u(Y^H - C) - u(Y^L + B - C) \leq u(Y^H) - u(Y^L) \). We define this as moral hazard I: the disincentive to supply effort because agents are insured from losses in bad states. Due to moral hazard I, agents supply less effort under formal insurance than under autarky. So we reach to our first prediction:

**Prediction 1:** \( x^A > x^I > 0 \).

### 2.2 Voluntary formal insurance

Now consider the case when agents have to choose an insurance plan from a menu of coverage and premium pairs including the choice of no insurance \((B \geq 0, C \geq 0)\). Given \( Y^H - Y^L \geq B \), and their choice for \( B \) and \( C \), the agents’ optimal probability under voluntary formal insurance, \( p^IC \), and optimal effort \( x^IC = f^{-1}(p^IC) \) is again determined by (5), which is the first order condition maximizing (4). Does voluntary formal insurance decrease the supply of effort as well? Choice of actuarially fair formal insurance coverage changes the prediction for effort under compulsory insurance only slightly. When agents do not want insurance, they behave as under autarky (and there is no moral hazard I). So when \( B=0 \), \( x^IC = x^A \). When agents are fully insured, \( Y^H - Y^L = B \), then they should not work \( x^IC = 0 \) due to moral hazard I in the context of full insurance. For other values of \( B \) there is moral hazard I and agents supply effort less than autarky \( x^IC < x^A \), because marginal benefit for extra effort is lower with insurance. Unless agents do not buy insurance, access to voluntary formal insurance decreases effort (proof, see Appendix 4.A.1).
Prediction 2: $x^A > x^{IC} \geq 0$.

2.3 Compulsory informal insurance

Now consider the two selfish agents, $i$ and $j$, who form an informal insurance network through sharing output with full commitment. Their informal insurance contract requires that agents $i$ and $j$ transfer a portion of their production to the other in case they are in a good state and the other is in a “bad state”. There are four possible states of nature: (i) both agents $i$ and $j$ receive high output $(Y^H, Y^H)$; (ii) agent $i$ receives high output and agent $j$ receives low output $(Y^H, Y^L)$; (iii) agent $i$ receives low output and agent $j$ receives high output $(Y^L, Y^H)$; (iv) or both agent $i$ and $j$ receive low output $(Y^L, Y^L)$. At the end of each year the agent with high output makes a transfer, $0 \leq \tau \leq Y^H$ to the agent with $Y^L$. We assume that the agent with low output does not make transfers to the other. We further assume that agents do not make transfers to each other in states when they both obtain equally high or low output, because transfers are not feasible in those states. As a result informal transfers occur only in the states of natures described in (ii) and (iii).

Denote by $p_i \in [0,1]$ the probability for high output chosen by the agent $i$ and by $p_j \in [0,1]$ the probability for high output chosen by the agent $j$. We focus on a case where decisions $p_i$ and $p_j$ are independent. The expected utility for agents $i$ under informal insurance coverage is given by:

$$EU_i = p_ip_ju(Y^H_i) + p_i(1 - p_j)u(Y^H_i - \tau_{ij}) + p_j(1 - p_i)u(Y^L_i + \tau_{ji}) + (1 - p_i)(1 - p_j)u(Y^L_i) - \omega(p_i)$$

(6)

For compulsory informal insurance, the amount of transfer $\tau_{ij} = \tau_{ji} > 0$ is fixed. Denote by $p_i^S$, the optimal probability for high output chosen by the agent $i$, and by $p_j^S$, the
optimal probability for high output chosen by the agent \( j \). Optimal probability to receive high output under compulsory informal insurance, \( p^S \), and optimal effort \( x^S = f^{-1}(p^S) \) is determined by the first order condition maximizing (6):

\[
p_j \left( u(Y_i^H) - u(Y_i^L) \right) + (1 - p_j) \left( u(Y_i^H - \tau_{ij}) - u(Y_i^L) \right) = \omega'(p_i^S) \quad (7)
\]

How does compulsory informal insurance effect the supply of effort in comparison to autarky? To answer this we re-write (7) as follows:

\[
u(Y_i^H) - u(Y_i^L) - g(p_j, \tau_{ij}, \tau_{ji}, Y_i^H, Y_i^L) = \omega'(p_i^S) \quad (8)
\]

where \( g(p_j, \tau_{ij}, \tau_{ji}, Y_i^H, Y_i^L) \) represents moral hazard; the disincentive to supply effort under informal insurance. \( g(p_j, \tau_{ij}, \tau_{ji}, Y_i^H, Y_i^L) \) contains two types of moral hazard (see Appendix 4.A.2). The first term is, moral hazard I; the marginal loss from supplying effort when insurance from agent \( j \) is available to the agent \( i \). The second term is moral hazard II; the marginal loss from sharing with agent \( j \), when agent \( i \) receives high output and agent \( j \) receives low output. Both moral hazard I and moral hazard II dis-incentivize agent \( i \) to supply effort in an informal insurance network.

So our second prediction is as follows:

**Prediction 3:** \( x^A > x^S \geq 0 \).

Is supply effort by agent \( i \) higher under compulsory formal insurance or compulsory informal insurance, when nominal benefits and cost are same, \( C = (B - C) = \tau_{ij} \) ? To answer this, we re-formaluate (7) and express it as

\[\text{\ }3\ \text{Depending on probability of loss } p.\]
\[ u(Y_i^H - \tau_{ij}) - u(Y_i^L + \tau_{ji}) + h(p_j, \tau_{ij}, Y_i^H, Y_i^L) = \omega'(p_i^S) \]  

(9)

where \( h(p_j, \tau_{ij}, \tau_{ji}, Y_i^H, Y_i^L) = (1 - p_j) \left( u(Y_i^L + \tau_{ji}) - u(Y_i^L) \right) + p_j \left( u(Y_i^H) - u(Y_i^H - \tau_{ij}) \right) \)

(see Appendix 4.A.3 for derivation). The term \( u(Y_i^H - \tau_{ij}) - u(Y_i^L + \tau_{ji}) \) captures the marginal benefit of supplying effort under formal insurance, \( u(Y_i^H - C) - u(Y_i^L + B - C) \)

from (5). Equation (9) is then \( \omega'(p_i^S) = \omega'(p_i^I) + h(p_j, \tau_{ij}, Y_i^H, Y_i^L, \cdot) \). To understand whether under informal insurance agents supply more effort, we focus on \( h(p_j, \tau_{ij}, Y_i^H, Y_i^L, \cdot) \). First consider the case when both agent \( i \) and \( j \) receive low output, \( Y^L \), and neither of them benefits from informal insurance. The first term of \( h(p_j, \tau_{ij}, \tau_{ji}, Y_i^H, Y_i^L) \) is in case equal to zero, therefore the marginal benefit of supplying effort is higher under compulsory informal insurance than under compulsory formal insurance. Second consider the case that both agents receive \( Y^H \) and neither of the agents has to transfer \( \tau \) to the other agent. The second term of \( h(p_j, \tau_{ij}, \tau_{ji}, Y_i^H, Y_i^L, \cdot) \) is equal to zero, indicating that marginal benefit of supplying more effort higher under compulsory informal insurance than under compulsory formal insurance. Since both cases stimulate effort, our fourth prediction is:

**Prediction 4**: \( x^I < x^S \).

### 2.4 Voluntary informal insurance

Finally, we consider a case when agents \( i \) and \( j \) not only choose their probabilities for high output, but also how much they will transfer to each other. In this case agents \( i \) and \( j \) have to form beliefs about their partner’s transfer choices, and probability for high output choice, and then decides on his or her transfer choice and choice of probability for high output. In equilibrium, agent \( i \) anticipates \( \tau_{ji} \) in case of \( (Y^L, Y^H) \), and agent \( j \) anticipates \( \tau_{ij} \) in case of
\((Y^H, Y^L)\). Optimal effort level \(x^{SC}\) for the agent \(i\) under voluntary informal insurance is derived from equation (8). If agent \(i\) forms a belief \(b_i(p_j = 0)\), because of moral hazard II, optimal choice of transfers is \(\tau_{ij} = 0\), and \(x^{SC} = x^A\). If agent \(j\) forms a belief \(b_i(p_j = 1)\), because of agent \(j\)’s moral hazard II, \(\tau_{ji} = 0\), and \(x^{SC} = x^A\). Optimal transfers are \(\tau_{ij} = \tau_{ji} = 0\), and agents supply effort equal to autarky level.

**Prediction 5:** \(x^A = x^{SC}\).

From model predictions, we obtain five testable hypotheses. (1) effort with compulsory formal insurance is lower than effort in autarky; (2) effort with voluntary formal insurance is lower than effort in autarky; (3) effort with compulsory informal insurance is lower than effort in autarky; (4) effort with compulsory formal insurance is lower than effort with compulsory informal insurance; (5) effort with voluntary informal insurance is the same as effort in autarky.

### 3 Experiment setup

We designed an experiment to test these predictions. The experiment was conducted in the Uganda district of Nakaseke in March 2014. The district is largely rural, with 82% of the population living in villages (MOWE, 2010). The main economic activity in the district is agriculture, comprising livestock production including cattle, goats, sheep, pigs and poultry, and cultivation of crops including coffee, maize, rice, beans, and plantain. Most people engage in social and economic groups within their villages, and at common places like markets. In addition to friends and family, these groups form the main source of safety net in case of shocks in income. People hardly use formal insurance schemes. We randomly selected 20 villages from the district, and from each village we randomly selected 14 households (adult members, male or female heads) to participate in the experiment. After explaining the
experiment protocol (see Appendix 4.B) to all participants together, we randomly assigned them into two groups: 6 people to the formal insurance group, and 8 people to the informal insurance group. In total 120 participants were assigned to the formal insurance group, and 160 participants were assigned to the informal insurance.\textsuperscript{4}

At the beginning of the experiment all participants were informed that they were going to play a risky production game for 15 rounds. Participants were assigned the role of agricultural producers, and were informed that they would be invited to engage a real effort task involving the sorting of beans at the beginning of each round. The probability of a good state, $p$, with high output $Y^H$ is increasing in the amount of beans sorted.

Each round, subjects were given a container of 4000 grams of proportionally mixed yellow and maroon beans. Subjects had 3 minutes to sort beans according to colour. When three minutes were over, enumerators weighed the sorted beans for that round. Subjects earned 1 blue ball per 10 grams of sorted beans, replacing red balls from a bag containing 32 red balls (initially). Enumerators then asked subjects to draw a ball from the bag, to determine their output for the round. Subjects earned $Y^H=10000$ shillings when drawing a blue ball, and $Y^L=2,000$ shillings when drawing a red ball. For instance when a subject sorted 160 grams of beans, then the bag contained 16 blue balls and 16 red balls, so that the subject’s chance to earn 10000 Shillings was $16/32=0.5$ for that round.

3.1 \textit{Treatments}

Each subject played this game under three treatments that each lasted for 5 rounds. The nature of the treatments varied, depending on assignment to either the formal or informal

\textsuperscript{4} In one villages, one participant in the informal insurance group did not play the autarky treatment.
insurance group. Subjects assigned to the formal insurance group played the game under conditions of (i) autarky, (ii) compulsory formal insurance, and (iii) voluntary formal insurance treatments. Subjects assigned to the informal insurance group played the game under conditions of (i) autarky, (ii) compulsory informal insurance, and (iii) voluntary informal insurance treatments. Details of the treatments are as follows.

**Autarky (Control treatment):** Subjects engaged in the production task without any form of insurance. Each subject either earned per period \(Y^H = 10000\) when picking a blue ball or \(Y^L = 2000\) when picking a red ball.

**Compulsory formal insurance:** Subjects had to buy formal insurance coverage from the enumerator, costing a premium, \(C\), of 3000 shillings each round and paying a benefit, \(B\), of 6000 shillings at the rounds (when the subject drew a red ball). So the insurance was partial and covered 75\% of the loss (75\%=6000/8000) and the insurance packages offered was actuarially fair based on average probability of loss at village level \((p = 0.5)\), calculated during test experiments. Subjects earned \(Y^H - C = 7000\) when they picked a blue ball, and earned \(Y^L + B - C = 5000\) when they picked a red ball.

**Voluntary formal insurance:** This treatment was similar to the previous treatment, but subjects chose their insurance coverage from a menu of insurance products with premium and coverages as summarized in column 1 of Table 1. At the beginning of each round, subjects privately informed the enumerator the level of coverage (and associated premium) they wanted to buy.

**Compulsory informal insurance:** At the beginning of the treatment each subject was randomly paired with another subject within their experimental group, and this pair was kept fixed throughout the treatment. When a pair’s earnings differed \((Y^H, Y^L)\) or \((Y^L, Y^H)\), the
subject who drew a blue ball (and earned $Y^H=10000$) had to transfer $\tau=3000$ Shillings to the partner drawing a red ball (and earned $Y^L=2000$). After sharing, final earnings per period are $(Y^H - \tau = 7000, Y^L + \tau = 5000)$ or $(Y^L + \tau = 5000, Y^H - \tau = 7000)$. Subjects did not share if they had the same earnings: $(Y^H, Y^H)$ or $(Y^L, Y^L)$.

Voluntary informal insurance: At the beginning of the treatment, each subject was randomly paired with another subject from the group, and this pair was kept fixed for the 5 rounds. Subjects however, decided on the amount of money they would like to transfer to their peer in case of unequal earnings. At the beginning of each round, subjects privately informed the enumerator about the size of their transfer by using a list of transfer choices summarized in Column 2 of Table 1.

Table 1: Choice sets

<table>
<thead>
<tr>
<th>Transfers/Coverage</th>
<th>Voluntary formal insurance (1)</th>
<th>Voluntary informal insurance (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coverage (%)</td>
<td>Premium (shs)</td>
</tr>
<tr>
<td>Full</td>
<td>100</td>
<td>4000</td>
</tr>
<tr>
<td>High</td>
<td>75</td>
<td>3000</td>
</tr>
<tr>
<td>Average</td>
<td>50</td>
<td>2000</td>
</tr>
<tr>
<td>Low</td>
<td>25</td>
<td>1000</td>
</tr>
<tr>
<td>Zero</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

3.2 Order of Treatments

We visited 20 villages, and played the five treatments in all villages: autarky, compulsory formal and informal insurance, and voluntary formal and informal insurance.
Table 2 summarizes the final distribution of orders by the treatments. There are six possible orders for three treatments; and as a consequence of random ordering, some orders were played more frequently than others. We control for order of play of treatments in our econometric analysis. Each subject played a total of 15 rounds. We use a series running from 1 to 15 to indicate the rank at which a round was played. For instance if the order of play for a village was voluntary (in)formal insurance first, followed by compulsory (in)formal insurance and lastly autarky treatment, then rounds for voluntary (in)formal insurance would take ranks from 1-5, followed by compulsory (in)formal insurance with ranks 6-10 and lastly autarky treatment with rank 11-15.

### Table 2: Order of play of treatments

<table>
<thead>
<tr>
<th>Order</th>
<th>Autarky</th>
<th>Compulsory (in)formal insurance</th>
<th>Voluntary (in)formal insurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>10</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Second</td>
<td>4</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Third</td>
<td>6</td>
<td>6</td>
<td>8</td>
</tr>
</tbody>
</table>

#### 3.3 Payments

At the end of each round, enumerators computed subjects’ earnings depending on the colour of the ball picked and insurance payments or transfers. Enumerators informed subjects individually about their earnings for that round. Out of five rounds for each treatment, one round was randomly picked per participant for actual payment. After the experiment, enumerators paid each subject the sum of the earnings from the three selected rounds: one from the autarky treatment, one from compulsory (in)formal insurance, and one from the voluntary (in)formal insurance treatments.
3.4 Exit Survey

We recorded earnings, transfers, choices for insurance, and effort (grams sorted) across rounds, and organized a short exit survey with questions about socio-economic and demographic characteristics after the experiment. The exit survey also included hypothetical risk aversion and time preference games. Table 3 summarizes key subject characteristics, and provides a balance test. Random assignment of participants to the formal and informal insurance group “worked.” Most subjects have a small area of land, are married, middle aged, and finished primary school. A good number of participants belong to a Savings, Credit and Cooperative Organisation (SACCO), and very few have formal insurance coverage. Because of the small sample size it is perhaps not surprising that we also have a lack of balance for some variables: farming, household head status, discount rates, and SACCO membership. To mitigate confounding effects due to lack of balance we control for subject fixed effects in our estimations.

1. Table 3: Summary of Socio-economic characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Mean</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Formal Insurance group (%)</td>
<td>Informal Insurance group (%)</td>
<td>(1=2)</td>
</tr>
<tr>
<td>Farm size (acres)</td>
<td>3.23</td>
<td>3.07</td>
<td>0.72</td>
</tr>
<tr>
<td>Farm output (million shillings)</td>
<td>0.86</td>
<td>0.73</td>
<td>0.25</td>
</tr>
<tr>
<td>Number of assets</td>
<td>4</td>
<td>4</td>
<td>0.45</td>
</tr>
<tr>
<td>Age</td>
<td>41.30</td>
<td>42.52</td>
<td>0.48</td>
</tr>
<tr>
<td>Household size (people)</td>
<td>8</td>
<td>8</td>
<td>0.84</td>
</tr>
</tbody>
</table>

5 In one village one participant for the formal insurance group did not participate in the exit survey.
<table>
<thead>
<tr>
<th></th>
<th>Female</th>
<th>Married</th>
<th>Household head</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major occupation-farming</td>
<td>0.75</td>
<td>0.63</td>
<td>0.03</td>
</tr>
<tr>
<td>Employ hired labour</td>
<td>0.41</td>
<td>0.37</td>
<td>0.47</td>
</tr>
<tr>
<td>Primary education</td>
<td>0.88</td>
<td>0.89</td>
<td>0.75</td>
</tr>
<tr>
<td>Post primary education</td>
<td>0.28</td>
<td>0.24</td>
<td>0.46</td>
</tr>
<tr>
<td>Member of SACCO</td>
<td>0.39</td>
<td>0.48</td>
<td>0.12</td>
</tr>
<tr>
<td>Risk averse (hypothetical)</td>
<td>0.56</td>
<td>0.49</td>
<td>0.21</td>
</tr>
<tr>
<td>low discount rate (hypothetical)</td>
<td>0.36</td>
<td>0.22</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Coping mechanisms**

<table>
<thead>
<tr>
<th></th>
<th>Gifts from family and friends</th>
<th>Borrow from family</th>
<th>Borrow from friends</th>
<th>Borrow from SACCO</th>
<th>Formal insurance coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.16</td>
<td>0.05</td>
<td>0.19</td>
<td>0.13</td>
<td>0.00</td>
</tr>
</tbody>
</table>

---

4 Identification

4.1 *Formal and informal insurance and effort*

Using data from the experiment we estimate the following model to test predictions 1-5:

\[
E_{ij} = \\
\beta_1 + \beta_2 \text{Compulsory formal}_{ij} + \beta_3 \text{Voluntary formal}_{ij} + \beta_4 \text{Compulsory informal}_{ij} + \\
\beta_5 \text{Voluntary informal}_{ij} + \mu'R_j + \gamma'X_i + \epsilon_{ij}, \tag{10}
\]
where $E_{ij}$ is the amount of sorted beans by subject $i$, in round $j$ (in grams), $Compulsory\ formal$, $Voluntary\ formal$, $Compulsory\ informal$, $Voluntary\ informal$, are binary variables indicating the relevant treatment arm (taking value of 0 otherwise). Autarky is the omitted category in regression model (10). $R_j$ is a vector including dummies for the rank at which each round was played, controlling for order of play of treatments, $X_i$ is a vector for subject dummies, controlling for unobserved subject fixed effects, and $\varepsilon_{ij}$ is the error term. Coefficient $\beta_2$ estimates the difference between effort under compulsory formal insurance and effort in autarky. Due to moral hazard I (prediction 1), we expect $\beta_2 < 0$. Coefficient $\beta_3$ measures the difference between effort under voluntary formal insurance and effort in autarky. Depending on the level of coverage bought, we expect (prediction 2) $\beta_3 < 0$. Coefficient $\beta_4$ estimates the difference between effort under compulsory informal insurance and effort in autarky. Due to moral hazard I and moral hazard II (prediction 3), $\beta_4 < 0$. Our model also predicts (prediction 4) that effort under compulsory formal insurance is lower than effort under compulsory informal insurance, therefore $\beta_2 - \beta_4 < 0$. Coefficient $\beta_5$ measures the difference between effort under voluntary informal insurance and effort in autarky. We expect (prediction 5) average transfers to be zero and $\beta_5 = 0$.

4.2 Heterogeneity and learning effect

We also explore whether moral hazard incentives under insurance coverage are different for subgroups of subjects with different characteristics. To do this we estimate the above regression model separately for males and females, young and old subjects, and primary and post-primary educated subjects. We also explore whether experience with SACCOs and the level of risk aversion (hypothetical) matter. We compare results across subsamples to the full
sample results. We also zoom in on the scope for learning, and re-estimate the model for the first two rounds and the last three rounds separately.

4.3 Experience with formal insurance

A recent study by Cai and Song (2017) finds that experiencing “bad outcomes” promotes the adoption of weather insurance. We seek to test the hypothesis that subjects learn about the value of insurance after suffering a bad outcome, and estimate model (11):

\[ c_{ij}^k = \delta_0 + \delta_1 B_{ij-1} + \delta_2 E_{ij} + \mu' R_j + \gamma' X_i + \varepsilon_{ij} \]  

(11)

where \( c_{ij}^k \) is the \( k \)th coverage chosen by subject \( i \), in round \( j \). \( B_{ij-1} \) is ball picked by subject \( i \), in round \( j - 1 \). \( E_{ij} \) is grams of sorted beans for subject \( i \), in round \( j \). \( R_j \) is a vector including dummies for the rank at which the each round was played, \( X_i \) is a vector of subject dummies, and \( \varepsilon_{ij} \) is the error term. Coefficients \( \delta_1 \) and \( \delta_2 \) measure the effect of bad outcomes and past effort on coverage choice, respectively.

We estimate (10) and (11) using OLS. We use heteroscedasticity robust standard errors clustered at the subject level to control for the fact that the choices of an individual across rounds are not independent observations. First we estimate a parsimonious version of our model with only treatment dummies and round dummies. In our preferred specification we also add subject fixed effects to control for unobserved subject characteristics.

5 Results

Our main results are given in Table 4 Column (1) is the parsimonious specification, and column (2) is the preferred specification.
### Table 4: Effect of insurance on effort

<table>
<thead>
<tr>
<th></th>
<th>Effort</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Compulsory formal insurance</td>
<td>7.80**</td>
</tr>
<tr>
<td></td>
<td>(3.27)</td>
</tr>
<tr>
<td>Voluntary formal insurance</td>
<td>5.96</td>
</tr>
<tr>
<td></td>
<td>(3.74)</td>
</tr>
<tr>
<td>Compulsory informal insurance</td>
<td>-8.50***</td>
</tr>
<tr>
<td></td>
<td>(2.80)</td>
</tr>
<tr>
<td>Voluntary informal insurance</td>
<td>-11.42***</td>
</tr>
<tr>
<td></td>
<td>(2.78)</td>
</tr>
<tr>
<td>Autarky</td>
<td>154.65***</td>
</tr>
<tr>
<td></td>
<td>(2.87)</td>
</tr>
</tbody>
</table>

N = 4,195
R-squared = 0.087
Order dummies = YES
Subject dummies = NO

**Hypothesis tests**

<table>
<thead>
<tr>
<th>Prediction</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prediction 1: $\beta_2 &lt; 0$</td>
<td>[0.99]</td>
<td>[0.66]</td>
</tr>
<tr>
<td>Prediction 2: $\beta_3 &lt; 0$</td>
<td>[0.94]</td>
<td>[0.38]</td>
</tr>
<tr>
<td>Prediction 3: $\beta_4 &lt; 0$</td>
<td>[0.00]</td>
<td>[0.05]</td>
</tr>
<tr>
<td>Prediction 4: $\beta_2 - \beta_4 &lt; 0$</td>
<td>[0.10]</td>
<td>[0.92]</td>
</tr>
<tr>
<td>Prediction 5: $\beta_5 = 0$</td>
<td>[0.00]</td>
<td>[0.00]</td>
</tr>
</tbody>
</table>

Robust standard errors, clustered at subject level, in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. p-values in brackets.

First, observe that the constant in column (1) shows that subjects sorted around 170 grams in the autarky case. As a result they earned around 17 balls on average, providing them with 53% probability of earning “high output.” Agents supply a considerable amount of effort when there is no insurance.

Now we turn to our model predictions. Predictions 1 and 2 state that access to formal insurance invites moral hazard, causing subjects to decrease their effort. Our experimental results however do not support these predictions. While the reverse seems true according to the parsimonious specification, we find that formal insurance does not affect effort in the full
model. Since the estimated coefficients for compulsory formal and voluntary formal insurance are not statistically smaller than zero, we conclude that formal insurance did not invite moral hazard.

Next consider the results for informal insurance, with which our respondents are much more familiar with. The model predicts that average effort should be lower than under autarky (prediction 3), and exceed effort with compulsory formal insurance (prediction 4). While our results are consistent with prediction 3, they do not support prediction 4. Respondents reduce their effort and sort 3 grams less in the compulsory informal insurance regime compared to autarky. This reduction corresponds to a 0.1 standard deviation change. There is also a significant difference between compulsory formal and compulsory informal insurance. This suggests, somewhat counterintuitively, that subjects in our sample took advantage of their informal insurance networks, but not of the formal insurance.

Finally, our results for voluntary informal insurance are not in line with model prediction 5. We predicted that subjects would not make transfers to their partners and would not expect any transfers in return – a return to autarky. But contrary to model predictions, 89% of the respondents choose positive transfer amounts: on average, subjects transferred about 1500 shillings to their partner. This average transfer amount is smaller than the compulsory informal insurance transfer of 3000 shillings.

We find that in the voluntary informal insurance treatment, respondents sort fewer beans. This means transfer and effort choices are consistent. Subjects reduced effort by 6 grams (compared to autarky), which is consistent with moral hazard II. Hence, while subjects chose to make positive transfers, they sorted fewer beans and attenuated the possibility that they actually had to provide the transfer. Results in Table 4 also show that effort across the two
informal insurance schemes are different \((p = 0.1)\). This suggests the two types of moral hazard may be additive.

When comparing the formal and informal insurance treatments, an important factor is the fact that villagers were matched with co-villagers (“peers”) in the informal insurance treatments. This could invite altruism (Alger & Weibull, 2010; Belhaj & Deroian, 2012), and image motivations (Benabou & Tirole, 2011). However, and contrary to expectations, we find that subjects supply less labour with informal insurance. In contrast, altruism and image concerns should have invited additional effort (so as not to free ride on transfers from peers, and to increase the probability of being able to help a peer). We conclude that insofar as altruism and image concerns are relevant, they are dominated by something else.

Perhaps the difference between the formal and informal insurance treatments is the extent to which subjects are familiar with the main concept, and understand its workings. Previous studies on insurance take-up in developing countries show that often economic agents from developing countries are not familiar with insurance products, and do not fully understand the benefits of insurance (Ackah & Owusu, 2012; Eling et al., 2014; Giesbert, 2012). Only agents with high cognitive capacities take advantage of formal insurance instrument (Swami et al., 2012).

We next explore whether we find patterns in our data suggesting that subjects fail to understand the implications and behavioural imperatives of the uptake of formal insurance. We focus on formal insurance coverage choices from the voluntary formal insurance treatment. Moreover 87\% of the subjects bought positive coverage level, and on average (bought average coverage) paid 2000 shillings in premium. We first regress effort on dummies for four different insurance coverage levels (full, high, average, low) in Table 5. Prediction 2 states that supply of
effort should decrease with the coverage level. After controlling for treatment order and subject characteristics, coverage level is not statistically different from zero. Hence, coverage does not reduce the supply of effort. There is therefore evidence that our subjects did not understand insurance product well and behaved irrationally.

Table 5: Effect of coverage level on effort

<table>
<thead>
<tr>
<th>Coverage</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>-44.42***</td>
<td>-48.92***</td>
<td>-11.11</td>
</tr>
<tr>
<td></td>
<td>(15.06)</td>
<td>(14.27)</td>
<td>(10.02)</td>
</tr>
<tr>
<td>High</td>
<td>-34.44**</td>
<td>-41.62***</td>
<td>-6.85</td>
</tr>
<tr>
<td></td>
<td>(14.30)</td>
<td>(14.67)</td>
<td>(8.61)</td>
</tr>
<tr>
<td>Average</td>
<td>-35.08*</td>
<td>-42.96***</td>
<td>-8.20</td>
</tr>
<tr>
<td></td>
<td>(19.60)</td>
<td>(16.16)</td>
<td>(9.19)</td>
</tr>
<tr>
<td>Low</td>
<td>-25.16</td>
<td>-34.97**</td>
<td>-8.76</td>
</tr>
<tr>
<td></td>
<td>(17.22)</td>
<td>(17.05)</td>
<td>(9.63)</td>
</tr>
<tr>
<td>Autarky (Zero)</td>
<td>230.01***</td>
<td>196.35***</td>
<td>150.22***</td>
</tr>
<tr>
<td></td>
<td>(16.93)</td>
<td>(13.38)</td>
<td>(9.87)</td>
</tr>
</tbody>
</table>

Robust standard errors, clustered at subject level, in parentheses. ***p < 0.01, **p < 0.05, *p < 0.10.

Next we probe whether some subgroups understood the advantages of formal insurance better. We do not have a measure of cognitive ability, but did collect data on education backgrounds, experience with financial products, and a range of other variables. We re-estimate model (10) for different subgroups separately, and report results in Panel A of Table 6. Subgroup estimates are similar to the ones reported earlier, so we find no evidence of particular subgroups behaving “more rationally” than others.

Table 6: Effect of insurance on effort: Subgroups and learning effect
Panel A: Subject characteristics

<table>
<thead>
<tr>
<th></th>
<th>Compulsory formal insurance</th>
<th>Voluntary formal insurance</th>
<th>Compulsory informal insurance</th>
<th>Voluntary informal insurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>4.12</td>
<td>4.53</td>
<td>-6.67**</td>
<td>-8.59***</td>
</tr>
<tr>
<td></td>
<td>(4.10)</td>
<td>(4.52)</td>
<td>(3.07)</td>
<td>(2.93)</td>
</tr>
<tr>
<td>Male</td>
<td>-0.56</td>
<td>-3.58</td>
<td>0.75</td>
<td>-2.17</td>
</tr>
<tr>
<td></td>
<td>(2.95)</td>
<td>(3.56)</td>
<td>(2.27)</td>
<td>(2.37)</td>
</tr>
<tr>
<td>Young</td>
<td>1.52</td>
<td>-1.36</td>
<td>-0.36</td>
<td>-3.26</td>
</tr>
<tr>
<td></td>
<td>(3.43)</td>
<td>(4.19)</td>
<td>(2.64)</td>
<td>(2.66)</td>
</tr>
<tr>
<td>Old</td>
<td>0.17</td>
<td>-0.47</td>
<td>-5.73**</td>
<td>-9.57***</td>
</tr>
<tr>
<td></td>
<td>(3.43)</td>
<td>(3.66)</td>
<td>(2.72)</td>
<td>(2.64)</td>
</tr>
<tr>
<td>Post-primary</td>
<td>6.70</td>
<td>0.11</td>
<td>3.06</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(4.69)</td>
<td>(6.85)</td>
<td>(2.53)</td>
<td>(3.22)</td>
</tr>
<tr>
<td>Below post-primary</td>
<td>-1.27</td>
<td>-1.25</td>
<td>-5.13**</td>
<td>-8.26***</td>
</tr>
<tr>
<td></td>
<td>(2.74)</td>
<td>(2.87)</td>
<td>(2.39)</td>
<td>(2.29)</td>
</tr>
<tr>
<td>Member of SACCO</td>
<td>3.56</td>
<td>6.37</td>
<td>-1.99</td>
<td>-4.44</td>
</tr>
<tr>
<td></td>
<td>(4.88)</td>
<td>(4.81)</td>
<td>(3.05)</td>
<td>(2.87)</td>
</tr>
<tr>
<td>Non SACCO members</td>
<td>-0.40</td>
<td>-4.10</td>
<td>-4.07*</td>
<td>-7.36***</td>
</tr>
<tr>
<td></td>
<td>(2.48)</td>
<td>(3.36)</td>
<td>(2.35)</td>
<td>(2.64)</td>
</tr>
<tr>
<td>Risk averse</td>
<td>0.96</td>
<td>-3.79</td>
<td>-1.81</td>
<td>-5.61**</td>
</tr>
<tr>
<td></td>
<td>(2.91)</td>
<td>(3.60)</td>
<td>(2.78)</td>
<td>(2.56)</td>
</tr>
<tr>
<td>Non risk averse</td>
<td>1.02</td>
<td>2.85</td>
<td>-4.52*</td>
<td>-6.73**</td>
</tr>
<tr>
<td></td>
<td>(4.18)</td>
<td>(4.64)</td>
<td>(2.53)</td>
<td>(2.80)</td>
</tr>
</tbody>
</table>

Panel B: Learning effect

<table>
<thead>
<tr>
<th></th>
<th>Round 1&amp;2</th>
<th>Round 3,4 &amp;5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.60</td>
<td>1.59</td>
</tr>
<tr>
<td></td>
<td>(2.61)</td>
<td>(3.41)</td>
</tr>
<tr>
<td></td>
<td>-1.18</td>
<td>-0.33</td>
</tr>
<tr>
<td></td>
<td>(3.27)</td>
<td>(3.75)</td>
</tr>
<tr>
<td></td>
<td>-3.30</td>
<td>-2.99</td>
</tr>
<tr>
<td></td>
<td>(2.05)</td>
<td>(2.70)</td>
</tr>
<tr>
<td></td>
<td>-5.84***</td>
<td>-6.46**</td>
</tr>
<tr>
<td></td>
<td>(2.14)</td>
<td>(2.72)</td>
</tr>
</tbody>
</table>

Dependent variable is effort. To save on space, we report only coefficients corresponding to the formal and informal insurance treatments; extra results are obtainable on request. Robust standard errors, clustered at subject level, in parentheses. ***p < 0.01, **p < 0.05, *p < 0.10. We control for order of play of treatments and subject fixed effects in all specifications.

Finally, we consider learning. Our subjects were not familiar with formal insurance before the experiment but may learn about it during the game. To test for learning, we explore whether moral hazard develops within the game: do formally insured subjects supply less effort at later stages of the game? We estimate model (10) again, but now introduce a binary variable taking the value of one for rounds three, four and five (and zero for rounds one and two).
Results are provided in panel B of Table 6, and do not support predictions 1 and 2 either. We next probe the role of learning by regressing coverage choices on a variable indicating whether the subject experienced “bad outcomes” in preceding rounds of the game. Results are given in Table 7, and are consistent with the hypothesis that subjects learn after experiencing a bad outcome. When subjects experienced a bad outcome, their likelihood of buying higher coverage levels increased. This result is robust to OLS and Ordered Probit estimations.

Table 7: Effect of Bad outcome on coverage

<table>
<thead>
<tr>
<th></th>
<th>Coverage level</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td></td>
</tr>
<tr>
<td>Bad outcome (L.1)</td>
<td>-0.26**</td>
<td>-0.27**</td>
<td>-0.18**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(0.12)</td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>Effort</td>
<td>0.01****</td>
<td>0.01***</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.84***</td>
<td>1.91***</td>
<td>1.84***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.34)</td>
<td>(0.35)</td>
<td>(0.30)</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.058</td>
<td>0.081</td>
<td>0.797</td>
<td></td>
</tr>
<tr>
<td>Pseudo R-squared</td>
<td>OLS</td>
<td>OLS</td>
<td>OLS</td>
<td></td>
</tr>
<tr>
<td>Method</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Order dummies</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>Subject dummies</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td></td>
</tr>
</tbody>
</table>

Robust standard errors, clustered at subject level, in parentheses. ***p < 0.01, **p < 0.05, *p < 0.10. The results are robust to ordered probit estimation.

4.6 Conclusion and Discussion

In absence of formal insurance institutions, households rely on informal insurance institutions to avert adverse fluctuations in consumption. Due to risk of concurrent bad states, reliance on informal insurance may have negative effects on overall insurance coverage. However uptake of formal insurance products is low. Lack of familiarity with formal insurance
product has been reported as one of the impediments for uptake. Without proper understanding, households may fail to take up insurance products, and let alone fully exploit them. Moral hazard incentives are therefore pertinent to uptake and to overall insurance coverage. Moral hazard incentives attenuate investment in self-protection. In this paper we examined moral hazard incentives associated with formal and informal insurance institutions. Unlike earlier studies, we compare effort incentives pertaining to formal insurance to effort incentives pertaining to informal insurance. Our model abstracts from a production context with uncertain returns to effort, and shows that formal insurance is associated with moral hazard I (disincentive for effort because households are insured from losses in bad states) and informal insurance is associated with both moral hazard I and moral hazard II (disincentive for effort because households do not want to share their high output in good states). Our model predicts that individuals work harder in autarky, and effort is higher with informal than with formal insurance.

We tested our theoretical predictions using a framed field experiment in a rural Uganda district. Our model correctly predicts behaviour with informal insurance relative to autarky. Consistent with model prediction, our empirical results show that relative to autarky, individuals reduce effort when they are part of compulsory informal insurance networks. We also find that with access to voluntary informal insurance, individuals instead reduce effort to avert transfer obligations.

We do not find evidence for moral hazard incentives with formal insurance. Contrary to the model prediction, empirical results show that agents did not reduce effort when they have access to formal insurance, relative to autarky. Our empirical results therefore suggest that access to formal insurance did not trigger moral hazard incentives.
These results confirm that people had difficulty grasping the idea of formal insurance – paying a premium every period to attenuate downside risk when the state of nature is “bad”. Their behaviour is clearly at odds with theoretical predictions. The deficiency of moral hazard incentives could not be explained by cognitive ability but by learning from experience, in particular bad shocks. However, people seem to understand informal insurance better, and their behaviour is consistent with moral hazard incentives. Many people in rural Africa rely on informal sharing networks to smooth consumption; so it is something they know and understand well. Our findings suggest that familiarity with insurance products is relevant for uptake. Supporting uptake of formal insurance products in poor and remote regions may necessitate awareness programmes to increase understanding.
References:


Appendix A

A.1

Taking total differential from equation (5), we obtain

$$\frac{dp^I}{dc} = \frac{u(Y^I + B - C) - u(Y^H - C)}{\omega^I(p^I)},$$

for $Y^H - Y^L > B$, $\frac{dp^I}{dc} > 0$, and for $Y^H - Y^L = B$, $\frac{dp^I}{dc} = 0$.

A.2

From equation (7), adding $(1 - p_j)u(Y^H_i)$ and subtracting $(1 - p_j)u(Y^H_i)$ on the left hand side, we obtain:

$$u(Y^H_i) - u(Y^L_i) + \left((1 - p_j)\left(u(Y^H_i - \tau_{ij}) - u(Y^H_i)\right) - p_j \left(u(Y^L_i + \tau_{ji}) - u(Y^L_i)\right)\right) = \omega^I(p^S_i)$$

Let $g(p_j, \tau_{ij}, Y^H_i, Y^L_i) = (1 - p_j)\left(u(Y^H_i - \tau_{ij}) - u(Y^H_i)\right) - p_j \left(u(Y^L_i + \tau_{ji}) - u(Y^L_i)\right)$, then

$$u(Y^H_i) - u(Y^L_i) + g(p_j, \tau_{ij}, Y^H_i, Y^L_i) = \omega^I(p^S_i).$$

Since $g(p_j, \tau_{ij}, Y^H_i, Y^L_i) < 0$, $\omega^I(p^A) > \omega^I(p^S)$, and $x^A > x^S$.

A.3

From equation (7), adding $(1 - p_j)u(Y^L_i + \tau_{ji})$ and subtracting $(1 - p_j)u(Y^L_i + \tau_{ji})$ on the left hand side, we obtain:

$$u(Y^H_i - \tau_{ij}) - u(Y^L_i + \tau_{ji}) + \left((1 - p_j)\left(u(Y^L_i + \tau_{ji}) - u(Y^L_i)\right) - p_j \left(u(Y^H_i - \tau_{ij}) -

u(Y^H_i)\right)\right) = \omega^I(p^S_i)$$
Let \( h(p_j, \tau_{ij}, Y^H_i, Y^L_i, ) = (1 - p_j) \left( u(Y^L_i + \tau_{ji}) - u(Y^L_i) \right) - p_j \left( u(Y^H_i - \tau_{ij}) - u(Y^H_i) \right) \), then

\[
\begin{align*}
u(Y^H_i - \tau_{ij}) - u(Y^L_i + \tau_{ji}) + h(p_j, \tau_{ij}, Y^H_i, Y^L_i, ) &= \omega'(p^S_i). \\
\end{align*}
\]

For \( \tau_{ij} = \tau_{ji} = C \); \( \omega'(p^I) + h(p_j, \tau_{ij}, Y^H_i, Y^L_i, ) = \omega'(p^S_i) \).

Since \( h(p_j, \tau_{ij}, Y^H_i, Y^L_i, ) > 0 \), \( \omega'(p^I) < \omega'(p^S) \), and \( x^I < x^S \).
Appendix B: Experiment Protocol

Welcome to this research experiment

Today we are going to engage you in a series of games. The games imitate fluctuating incomes of agriculture.

Farmers exert high or low effort, and sometimes get high output (earn high incomes) and sometimes they get low output (earn low incomes). So incomes of farmers fluctuate and they often take measures to cope or avert the fluctuations.

We are going to play many rounds of games.

We are going to play three versions of the game. In all the versions we will play 5 rounds. One round will be picked at random from each version for payment. That forms the three chances for earning money today.

Any questions so far?

Status quo:

In all the games we are going to play, you will be given mixed yellow and red beans to sort according to colour for three minutes, and afterwards enumerators will weigh the sorted beans together at ounce and grams sorted will be recorded. You will then earn blue balls according to grams sorted.

We have 2 bags, one containing 32 red balls, and another containing 32 blue balls. For each 10 grams of sorted beans, you earn one blue ball.

For example if you sort 200 grams you earn 20 blue balls, which you replace for 20 red balls, in the bag of 32 red balls.

We then after, we shall ask you close your eyes and draw one ball. A red ball drawn is worth 2000 and a blue ball drawn is worth 10,000 shillings.  

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6 This protocol was given to participants verbally, in local language.

7 Exchange rate: $1 = 2600 shillings.
In this game, we sort beans to increase the chances of drawing a blue ball (earning 10,000 shillings).

Communication between participants is not allowed.

Remember for each version, you will play for 5 rounds. One round will be picked at random from each version for payment. It can be a round where you earned 2000 or one where you earned 10000 shillings.

Enumerators will be calculating and recording your earnings and will let you know your earnings at the end of each round, should that round be picked at random for payment.

At the end of each version you will be asked to make a draw to determine the round you will be paid for, from that version at the end of the experiment. You will be informed about your earnings for that version, if you wish you can write it down.

It is important you understand the rules of the game, before we start the games.

Do you have any questions?

Enumerators will be reminding you of the status quo information at the beginning of each version.

We are going to proceed with the games, but in groups. I wish good luck beforehand.

We have a total of fourteen people here, we are going to randomly form two groups, one of six people (formal insurance group), and another of eight people (informal insurance group)\(^8\).

While in your group, before the start of the games, Enumerators will ask you to read or will read you through an informed consent form, and afterwards ask you to sign it. This is important for it shows you are participating in this experiment voluntarily, and that you aware that the information gathered will be analysed anonymously together with other information and treated confidentially, and used only for academic and research purposes. After the games, you will also engage in a short interview to enable us gather additional social and economic information.

**Formal insurance group**

*Version 1: Autarky game*

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\(^8\) Group names were not mentioned to participants.
Welcome to this version.

Each round, depending on the number of blue balls you earned from sorting beans, you will draw one ball from a bag containing 32 balls.

When you draw a red ball you earn 2000 shillings and when you draw a blue ball you earn 10,000 shillings.

We are going to play for 5 rounds, and at the end you will be asked to randomly pick one round to determine your earnings for this version.

**Version 2: Compulsory formal insurance game**

Welcome to this version.

Each round, depending on the number of blue balls you earned from sorting beans in that round, you draw one ball from a bag containing 32 balls.

In this version however you buy insurance.

The insurance cost a premium of 3000 shillings every round and pays a benefit of 6000 shillings in the rounds when subjects draw a red ball.

When you draw a red ball, the insurance company will compensate you 6000 shillings and after paying the premium you will earn 5000 shillings for that round. When you draw a blue ball, you do not receive compensation, but only pay the premium and you will earn 7000 shillings for that round.

We are going to play for 5 rounds, and at the end you will be asked to randomly pick one round to determine your earnings for this version.

**Version 3: voluntary formal insurance game**

Welcome to this version.

Each round, depending on the number of blue balls you earned from sorting beans in that round, you draw one ball from a bag containing 32 balls.
In this version however you prior decide on the amount of premium (insurance coverage) to pay.

You can buy 100% coverage (pay premium 4000 shillings and earn 6000 shilling with a blue or red ball) or 75% coverage (pay premium 3000 shillings and earn 7000 shillings with a blue ball or 5000 shillings with a red ball) or 50% coverage (pay premium 2000 shillings and earn 8000 shillings with blue ball and 4000 shillings with a red ball) or 25% coverage (pay premium 1000 shillings and earn 9000 shillings with a blue ball and 3000 shillings with a red ball) or 0% coverage (pay zero premium and earn 10000 shillings with blue ball or 2000 shillings with a red ball).

Depending on the amount of coverage you buy, when you draw a red ball, the insurance company will compensate you and you will pay premium as well. When you draw a blue ball, you do not receive compensation, but only pay the premium.

We are going to play for 5 rounds, and at the end you will be asked to randomly pick one round to determine your earnings for this version.

**Informal insurance scheme group**

*Version 1: Autarky game*

Welcome to this version.

Each round, depending on the number of blue balls you earned from sorting beans in that round, you draw one ball from a bag containing 32 balls.

When you draw a red ball, you earn 2000 shillings and when you draw a blue ball, you earn 10,000 shillings.

We are going to play for 5 rounds, and at the end you will be asked to randomly pick one round to determine your earnings for this version.

*Version 2: Compulsory informal insurance game*

Welcome to this version.
Each round, depending on the number of blue balls you earned from sorting beans in that round, you draw one ball from a bag containing 32 balls.

In this version however we randomly assign you a partner.

When you draw a red ball and your partner drew a blue ball, your partner will give you 3000 shillings and you will earn 5000 shillings for that round and your partner will earn their remaining 7000 shillings for that round. When you draw a blue ball and your partner drew a red ball, you will give your partner 3000 shillings and you will earn your remaining 7000 shillings for that round and your partner will earn 5000 shillings for that round. When you and your partner both draw a red ball, you both earn 2000 shillings and when you and your partner both draw a blue ball, you both earn 10,000 shilling.

We are going to play for 5 rounds, and at the end you will be asked to randomly pick one round to determine your earnings for this version.

*Version 3: Voluntary informal insurance game*

Welcome to this version.

Each round, depending on the number of blue balls you earned from sorting beans in that round, you draw one ball from a bag containing 32 balls.

In this version however you prior decide on the amount of money you give to your randomly assigned partner, in case you draw a blue ball and your partner draws a red ball.

You can decide to give your partner 4000 shillings or 3000 shillings or 2000 shillings or 1000 shillings or zero.

When you draw a red ball and your partner drew a blue ball, your partner will give you the amount they a prior decided on and you will earn 2000 shillings plus that amount for that round and your partner will earn 10,000 shillings minus that amount for that round. When you draw a blue ball and your partner drew a red ball, you will give your partner the amount you prior decided on and you will earn 10,000 minus that amount for that round and your partner will earn 2000 shillings plus that amount for that round. When you and your partner both draw a red ball, you both earn 2000 shillings plus that amount for that round and your partner will earn 10,000 shillings minus that amount for that round and your partner will earn 2000 shillings plus that amount for that round. When you and your partner both draw a red ball, you both earn 10,000 shillings minus that amount for that round and your partner will earn 2000 shillings plus that amount for that round.
ball, you both earn 2000 shillings and when you and your partner both draw a blue ball, you both earn 10,000 shilling.

We are going to play for 5 rounds, and at the end you will be asked to randomly pick one round to determine your earnings for this version.

*We thank you for your time.*