Insuring what matters most

Intrahousehold risk sharing and the benefits of insurance for women.

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Abstract

Economic shocks such as droughts and floods have disproportionate impacts on assets, nutrition, and health for women and girls. This paper develops a model to study investment under risk in settings where women are principally responsible for expenditures on household public goods. It predicts that when women increase their investment, men will share less of their income, which means that women's assets are the first to be liquidated in the event of a negative shock. Insurance linked to expenditures within women's traditional sphere within the household has the potential to insulate women's assets and consumption, increasing their expected returns to investment by increasing their share of household income in the event of a negative shock. To test this prediction, I conduct a lab-in-the-field experiment in Sambury County, Kenya using a tablet-based insurance game and find that women buy significantly more insurance when it is linked to household expenditures.

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Introduction

Droughts, floods, and other economic shocks cause hunger and perpetuate poverty. Costs are often disproportionately borne by women and girls, for whom being removed from school or temporarily malnourished can have lifelong consequences. Index insurance is a broadly applicable tool to help reduce the costs of economic shocks, but the design of existing products generally directs insurance payments to men. This paper develops an intrahousehold model that suggests directing insurance products toward women's budgets could increase demand for index insurance and its benefits, and finds support for that hypothesis using a lab-in-the-field experiment.

Women and girls often bear the brunt of economic shocks (Horton 1986; Sen 1990; Duflo 2005; Qian 2008; Akresh, Verwimp, and Bundervoet 2011). Hoddinott and Kinsey (2000) find that droughts adversely affect the body mass index (BMI) of women and daughters in Zimbabwean households, but not men and sons. Anttila-Hughes and Hsiang (2013) find that typhoons in the Philippines increase child mortality for female infants, but not males. Maccini and Yang (2009) show that Indonesian women who grow up in areas with lower-than-average rainfall during their early years are shorter, complete less school, and live in households with fewer assets later in life. Dercon and Krishnan (2000) find that when women get sick, they receive a smaller share of household nutrition, but the same is not true for men.

This paper develops a model to study how shocks are distributed within households. It focuses on households that follow traditional patriarchal gender roles and that are headed by one man and one woman to reflect the settings in which these disproportionate impacts are documented.[1] Each of the household members maintains control of their own assets, but primary responsibility for household public goods such as food and childcare falls to the

[1] The model could be extended to include polygamous or polyandrous households, but probably does not apply to households with two parents of the same gender unless one partner takes primary responsibility for household public goods.

wife. The core prediction of this theory is that women have less incentive to invest than men because men share less of their income with their wife when her income increases. This effectively means that women face lower returns to investment than men even when they are equally productive. At the same time, insurance is particularly valuable for women because it provides income when their husband's contribution is smallest.

This model provides an explanation for the short-lived impacts of poverty graduation programs on women's empowerment. Banerjee et al. (2015) conduct a long-term study of poverty graduation programs, which provide women substantial grants along with business training and other benefits. In the short run, the programs led to increases in women empowerment as well as household income, assets, and health measures. In the long run, all of the effects persisted except the positive effects on empowerment, which includes womens' control over household assets. This is consistent with the model, which predicts that in response to an increase in asset ownership by women, men will share less of their income and *increase* their own investment. Absent insurance, women sell their assets to finance household expenditures and their own consumption. Insurance can alter this dynamic by increasing expected returns to investment for women and shielding their own assets from risks on their husband's income.

Linking insurance to household expenses rather than assets increases demand among women in this framework for two reasons. First, linking insurance to household expenses draws attention to the fact that women are indirectly exposed to risk related to their husband's assets. Second, when household norms link different sources of income to gendered expenditures, the stated purpose of insurance is likely to affect who decides how to allocate indemnity payments.[2] In the context of the experiment in this paper, this means that livestock insurance is likely to be used to replace livestock while household insurance is likely to be used to pay household expenses.

[2]An example of this sort of norms is documented in Duflo and Udry (2004), where income earned by women and income earned from yam production is linked to household expenses, while other income men earn is discretionary.

The theory also yields a number of intuitive predictions that are consistent with published findings. It predicts productive inefficiency as documented by Udry et al. (1995) and Udry (1996) as well as the asymmetric effects of transfers to women and men on household expenditures documented by Duflo (2012) and others. It also predicts that women whose income is low relative to their husbands are likely to invest more than their husbands in children's goods and save less, as reported by Doepke and Tertilt (2019).

I test the theory in Samburu County, Kenya, where the dynamics predicted by the theory have been observed by the BOMA Rural Entrepreneurs Access Program (REAP), which provides poor women grants and training to start small businesses. Specifically, BOMA reports that when women start businesses, they also take a greater responsibility for household expenses such as food, school fees, and medical bills. When droughts strike, the entire local economy is affected, which means that even non-livestock businesses are often liquidated to finance household expenses. In Samburu, nearly all households earn their income as pastoralists who herd livestock, and droughts are the most important source of risk. Traditional gender roles also sharply delineate household responsibilities, making it an ideal environment to test the model. As the theory predicts, BOMA reports that when droughts strike, women liquidate their businesses to pay for household expenses. We invited a sample of women and their husbands to play a tablet-based drought insurance game, and tied the insurance to household expenses in half of the sessions. As predicted by the theory, women bought significantly more insurance when its benefits were framed around household expenses than when they were framed around livestock.

Theory

The theory presented in the following sections builds on the existing literature by considering how individual dynamic investment decisions are affected by intrahousehold dynamics and risk. It builds on the model developed in Lundberg and Pollak (1993) which predicts that income received by women and men will have different effects on household expenditures because of their distinct responsibilities within the household. I show that when this model is extended to a dynamic setting, the same mechanism that leads women to allocate more money toward public goods such as children's education and food discourage them from investing in productive assets.

The core concept underlying the model is the idea that in societies where men are the traditional breadwinner and transfer income to their wives, private returns to capital are effectively lower for women than for men. This is because men respond to increases in their wife's income by reducing transfers. This effectively acts as a tax on womens' investment. This provides a theoretical explanation for a number of findings, including evidence of underinvestment in agricultural plots controlled by women (Udry et al. 1995), lower returns to womens' business than men's (Bernhardt et al., n.d.) in two-earner households but not households headed by women, and the fact that women are less likely to take out loans than equally creditworthy men.

Insurance is a good investment for women who depend on transfers for their husband because it provides cash when transfers fall short. This means that insurance can be a good investment for women even if they do not own any assets, and I show theoretically that for women with low levels of assets relative to their husband, the it is optimal to more than fully insure their own assets. Further, I show that in the presence of risk, insurance can dramatically increase investment by women by shielding their consumption from direct as well as indirect risk.

Risk, Investment, and Gender

This paper builds on the 'separate spheres' household bargaining model with transfers described by Lundberg and Pollak (1993). A key feature of that model is that it incorporates the fact that women and men have traditionally have different roles within the household.

In particular, in many contexts, women are primarily responsible for household public goods such as food while men are primarily responsible for income generation. This structure means poor women are dependent on their spouse's income and are exposed to risk their partner takes.

There are three goods: private consumption for the man c_m, private consumption for the woman c_w, and household public consumption z. The man's utility function is $u_m(c_m, z)$. The woman's utility function is $u_w(c_w, z)$. I assume both are increasing and concave in both arguments, and that c_w, c_m and z are normal goods.

Production is given by an increasing and concave production function f, and investment for agent $i \in \{m, w\}$ is given by k_i. I assume that both the man and the woman have access to the same production technology. Production for agent i is also affected by a multiplicative shock ϵ_i, so for example total production for the woman is given by $f(k_w)\epsilon$.

Since the purpose of this paper is to study the benefits of insurance for women, I assume only women buy insurance. Allowing both agents to buy insurance complicates the model without providing useful insight: more insurance for the man can be thought of us a change in the distribution of ϵ. In other words, I study here the woman's insurance decision holding the level of risk of her partner's portfolio fixed.

The model has two periods. In each period, the man makes his choices first, followed by the woman. Since public good production z is decided by the wife based on her income y_w and the transfer she receives from her husband, from his perspective z is a function of those two factors.

An important feature of this model stemming from Lundberg and Pollak (1993) is the husband choice of a transfer is must be at least some minimum amount $\bar{t}$. The minimum transfer can be defined by laws or social norms, and may be zero or negative. In the specific context studied later in this paper, $\bar{t}$ stems from a norm that says that the man must allot the production of several livestock to his wife at the beginning of the marriage, and she has the sole right to the production from those animals for the duration of the marriage. In other contexts $\bar{t}$ could be due to different norms or child support laws, or it may be equal to zero and simply reflect that he cannot take control of his partner's income.

In the first period, the man starts with income y_m^1 and chooses a transfer payment to his wife, his own consumption, and investment. Household public goods z^1 are chosen by his wife; his transfer t^1 will affect her choice. I assume he knows his wife's income and preferences and therefore thinks of z^1 and y_w^1 as a function of y_w^1 and t^1:

$$\max_{c_m^1, t^1, k_m^1} u_m(c_m^1, z^1(y_w^1, t^1)) + \beta E[v_m(y_w^2(y_w^1, t^1), y_m^2)]$$

subject to the budget constraint:

$$c_m^1 + t^1 + k_m^1 \leq y_m^1$$

where y_w is his spouse's future income, y_m is his future income, and

$$y_m^2 = f(k_m^1)\epsilon$$

his choice must also satisfy the minimum transfer requirement $t^1 \geq \bar{t}$, and investment must be positive ($k_m^1 \geq 0$).

The function v_m is the optimized second period utility:

$$v_m(y_w^2, y_m^2) = \max_{c_m^2, t^2} u_m(c_m^2, z^2(y_w^2, t^2)) \text{ s.t. } c_m^2 + t^2 \leq y_m^2$$

The woman makes her choices second in each period, after her husband has selected t. She chooses her first period consumption c_w^1, the first period level of household public goods z^1, her investment level k_w^1 and her expenditure on insurance i_w:

$$\max_{c_w^1, z^1, k_w, i_w} u_w(c_w^1, z^1) + \beta E[v_w(y_w^2, y_m^2)]$$

subject to the budget constraint:

$$c_w^1 + z^1 + k_w^1 \leq y_w^1 + t^1$$

where y_m^2 is her spouse's future income, y_w^2 is her future income, and

$$y_w = f(k_w^1)\epsilon + g(i_w, \epsilon).$$

In other words, the woman's total income y_w is the sum of production from her investment f, indemnity payments from her insurance, and a transfer from her husband. The random shock ϵ takes a value between 0 (worst) and 1 (best). I assume that f is concave and increasing in k_w^1 and and that g is decreasing in ϵ but increasing in i_w. The woman cannot invest less than zero ($k_w^1 \geq 0$).

The function v_w is the woman's optimized second period utility:

$$v_w(y_w^2, y_m^2) = \max_{c_w^2, z^2} u_w(c_w^2, z^2) \text{ s.t. } c_w^2 + z^2 \leq y_w^2 + t^2$$

The key feature of this model is the fact that in general, the man's choice of t is decreasing in his wife's income and increasing in his own income. That means that for her, investment is subject to a 'tax' in the sense that increased income will be offset by a smaller transfer.[3] As discussed later in the paper, there is empirical support for this dynamic: participants in cash grant programs frequently described this as an effect of grants to women: men reduced or eliminated their support for household public goods when women received grants.

[3]This provides an explanation for the finding that women are more likely to use savings products when they can be kept secret (e.g. see Jakiela and Ozier (2015)).

The 'tax' described above does not apply, however, when the husband's choice of t is fixed at its minimum $\bar{t}$. In that case, since he cannot reduce his transfer further, the wife fully benefits from increased income. The key insight of this paper is that the constraint is most likely to bind in 'bad' states of the world because the husband's income is low. Absent insurance, this shifts risk onto the woman in bad states of the world, which discourages investment and makes maintaining a business difficult.

The results in this section provide a theoretical explanation for the observation that household investment decisions are often observed to be inefficient, with underinvestment in assets controlled by women.[4] It simply does not make sense for women to invest heavily when their increased production will be offset by a reduced transfer.

Investment

Even without risk, the model predicts productive inefficiency due to 'underinvestment' by women. This is because women who recognize that investment income will reduce future transfers from their husband will rationally choose to spend money on consumption and/or household public goods rather than invest it. Intuitively, this effect is strongest when husbands place relatively low value on household public goods.

In this section, I assume there is no risk ($\epsilon = 1$) and the woman buys no insurance ($i_w = 0$). The model has multiple equilibria: an equilibrium in which the wife is *dependent* on transfers from her husband, and another in which the wife's spending is *independent* of her husband's income. In the *dependent* equilibrium, which is the likely outcome when the woman has substantially less money than her husband, the household is productively inefficient.

For the analysis to follow, I assume both the wife and husband have Cobb-Douglas utility functions

$$u_w(c_w, z) = c_w^{\alpha_{cw}} z^{\alpha_z}$$

[4] See Udry et al. (1995) and Udry (1996).

and

$$u_m(c_m, z) = c_m^{\alpha_{cm}} z^{\alpha_z}$$

and that $\bar{t} = 0$. Here I will focus only on the main results: detailed derivations can be found in Appendix 4.

The key consideration that distinguishes the woman's first period decision from a typical investment decision is the fact that it affects her transfer. The husband's optimal transfer in period 2 is given in general by

$$t^2 = \min(\frac{\alpha_{zm} f(k_m^1)\epsilon - \alpha_{cm}(f(k_w^1)\epsilon + g(i^1, \epsilon))}{\alpha_{zm} + \alpha_{cm}}, \bar{t}).$$

Without risk or insurance and with $\bar{t} = 0$, the equation simplifies to:

$$t^2 = \begin{cases} \frac{\alpha_{zm} f(k_m^1) - \alpha_{cm} f(k_w^1)}{\alpha_{zm} + \alpha_{cm}} & \text{if } \alpha_{zm} f(k_m^1) > \alpha_{cm}(f(k_w^1) \\ 0 & \text{otherwise} \end{cases}$$

I call the first case in which $t^2 \geq \bar{t}$ *independence* and the second case in which she receives no transfer from her husband *dependence*. Since her transfer is diminishing in her investment until $\alpha_{cm} f(k_w^1) > \alpha_{zm} f(k_m^1)$, she effectively faces a non-convexity in her production function, which generates a poverty trap.

The equation for t^2 has an intuitive interpretation. When them man values household public goods highly, α_{zm} is larger and so is the transfer he provides. It also is less dependent on his wife's level of investment. When α_{cm} is large, the man places more value on his private consumption and so his transfer is more sensitive to his wife's investment. This means that the poverty trap is more marked for women whose husbands who place little value on household public goods.

As a result of her production dependent transfer, her second period income is also discon-

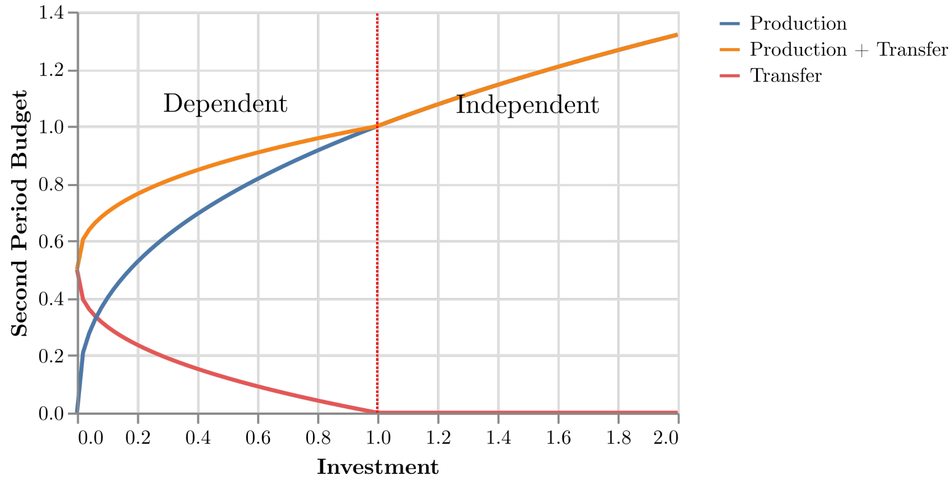

Figure 1: With insurance, optimal investment increases at low budgets

tinuous:

$$y_w^2 = \begin{cases} (f(k_w^1)\epsilon + f(k_m^1)\epsilon + g(i^1, \epsilon))\frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}} & \text{if } t^2 \geq \bar{t} \\ f(k_w^1)\epsilon + g(i, \epsilon) & \text{otherwise} \end{cases}$$

Figure 1 depicts the relationship between the wife's investment level and her income at the beginning of the second period in the simple situation in which both partners have identical Cobb-Douglas production functions, a concave production technology ($f(k) = k^{1/2}$), no production risk, and the man's investment is held constant at 1. The woman would never optimally select the point at which $t = \bar{t}$ since slightly increasing her investment would substantially increase her income and slightly decreasing it would increase her present consumption more than it would reduce her future income.

Because the woman effectively faces a production function with a nonconvexity, her optimal investment decision is not a continuous function. In particular, there are two important thresholds: the budget level at which she invests more than zero, moving from full dependence on her husband's investments to partial dependence, and the budget level at which she moves from partial dependence to independence.

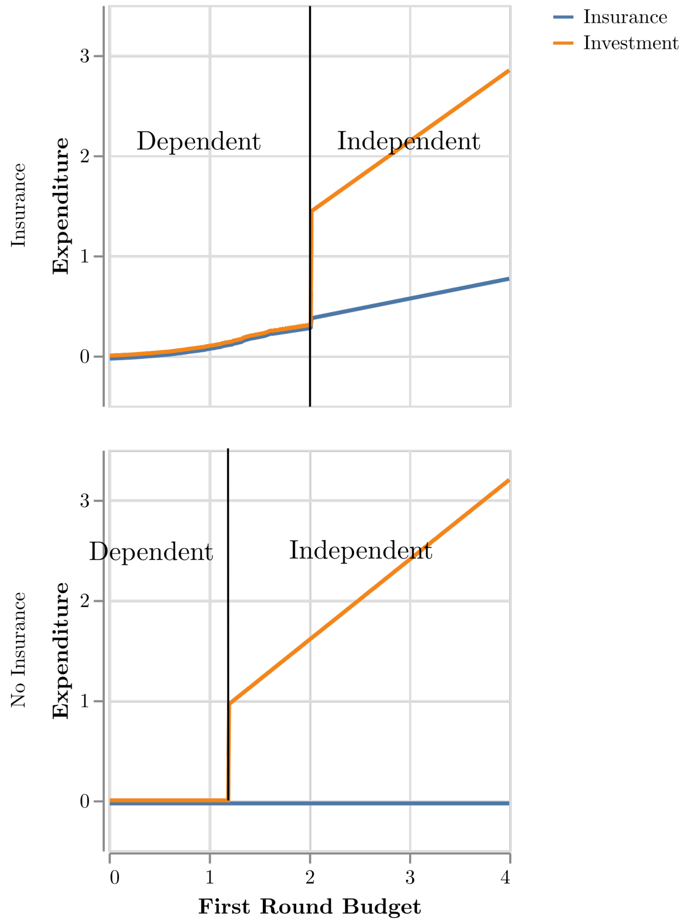

Figure 2: Insurance dramatically increases investment for women who are dependent on transfers from their husbands, and increases the maximum income at which they choose to remain dependent.

Risk and Insurance

In this model, insurance dramatically increases optimal investment levels for women who are dependent on transfers from their husbands. In settings with traditionally patriarchal gender roles, this is likely to describe a large share of women. Intuitively, this effect occurs because insurance increases the returns to investment in bad years by eliciting independence and allows women to shield themselves from indirect risk associatd with their husband's assets.

Figure 2 compares optimal portfolio choices with and without insurance.[5] As depicted,

[5]Specifically, a shock is drawn from a truncated normal distribution with a mean of 1 and a standard

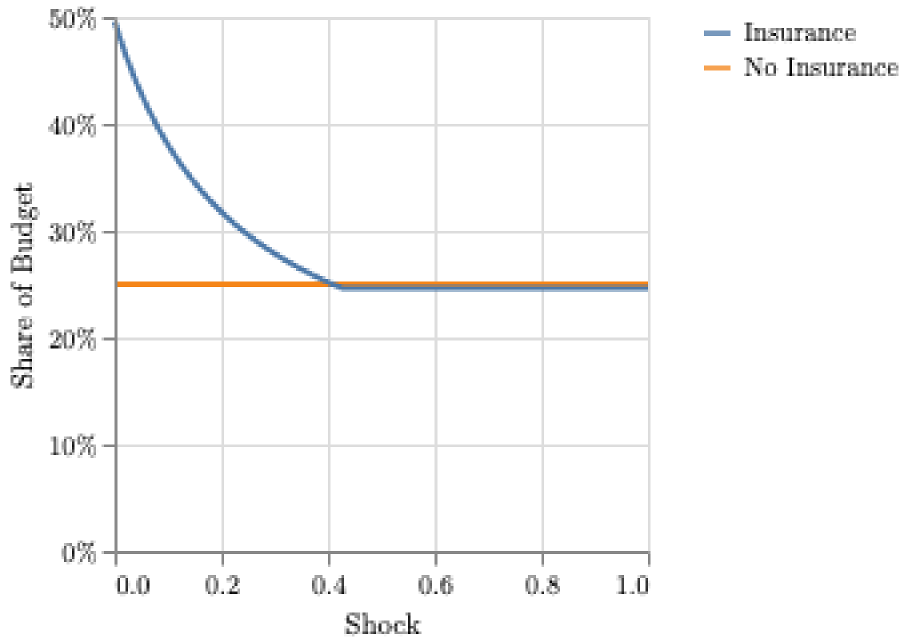

Figure 3: Household insurance is controlled by the woman and so increases her share of household income as well as the total amount of household income during a negative shock. Insurance controlled by the man has no effect on her share of income in the event of a drought, though it does increase household income.

optimal portfolio choices include purchase of insurance by women from both the dependent and independent groups. The availability of insurance also increases the first round budget required to induce independence.

Another way to frame the benefit of insurance for women is in terms of the share of household income she controls in the event of a negative shock. In the Cobb-Douglas framework I have been using throughout for graphical explanations, the woman's share of the total household budget is a constant fraction as long as her husband is providing her a positive transfer ($t > \bar{t}$). However, when her income is high enough that her husband pays the minimum transfer ($t = \bar{t}$), her *share* of household income is increasing in her own income. That means the insurance payment she receives has two effects: it increases household income and it increases her share of household income. I show the effect of optimal insurance on her income share visually in Figure 3.

deviation of 0.3. The insurance pays the difference between the shock and 1 if the shock is less than 1.

Household Insurance

The key implication of the theory above is that insurance has outsize benefits for women because it can increase their share of household income when it is most valuable: in the event of a crisis. Further, since the weather events such as droughts or floods are the principal risks farmers face, index insurance is an appropriate tool. However, since in most households cultivation of important cash crops is the role of the man, existing agricultural insurance products have been sold to men and indemnity payments have entered their incomes.

There are three reasons for linking insurance to household expenditures rather than investment. First, the optimal quantity of insurance to buy and the optimal amount to invest in her case are not tied together in a straightforward way. As shown above, it can be rational for a woman who depends on her husband's income to buy insurance even if she does not have any investments. More generally, even if a woman does invest, it may be optimal for her to more than fully insure her own investment. Second, in many settings most or all of a household's investments are made by men, men may claim power over indemnity payments linked to investments even if they did not buy the insurance contract. Of course, it is also possible that men will take control over payments linked to household expenses, but I argue that this is less likely when insurance is linked to expenses in the woman's traditonal sphere than when it is linked to assets in the man's traditional sphere. Third, it is conceptually easier to think about the quantity of money needed to buy essentials such as food and clothing in the event of a crisis than the share of production to insure.

Linking insurance to household expenditures draws attention to the linkage between risk that affects household assets and individual consumption. In many cases, assets are controlled by men, and for women buying insurance on those assets is counterintuitive. When women do not control assets, they do not need to insure assets, but they may want to insure their and their children's consumption. Further, it will likely be easier for women to argue that insurance payments that were always framed around household expenses should be allocated to household expenses.

The framing in the demand experiment I conducted reflects the theoretical and practical considerations laid out above. In the household insurance sessions, two enumerators selected as actors have a conversation in which one woman explains to the other that livestock risk translates into consumption risk. Insurance is then introduced as a way to make sure that food, medical bills, and school fees can be paid in a drought, despite the fact that milk production is limited and many animals may have died. In the livestock sessions, two women have a similar conversation, but insurance is explained as an income source designed to help offset asset losses and the linkage between those losses and household consumption is not emphasized. The fact that women buy more insurance under the household framing suggests this difference matters to them: household insurance does more to meet their needs in the event of a drought.

A Demand Experiment

The theory above suggests that for women, the optimal quantity of insurance may not be tied to the assets they own. Further, it suggests that insurance may have outsize benefits for women relative to men by increasing their share of household income in the event of a drought.[6] In order to test whether decoupling insurance from male-controlled assets increased demand among women, we designed a lab-in-the-field experiment using a tablet-based videogame. Our results support the hypothesis advanced by the theory: women are more likely to buy insurance when it is associated with household expenses rather than assets.

[6]For both women and men, insurance increases household income in the event of a drought. However, for women, it can additionally increase their *share* of household income.

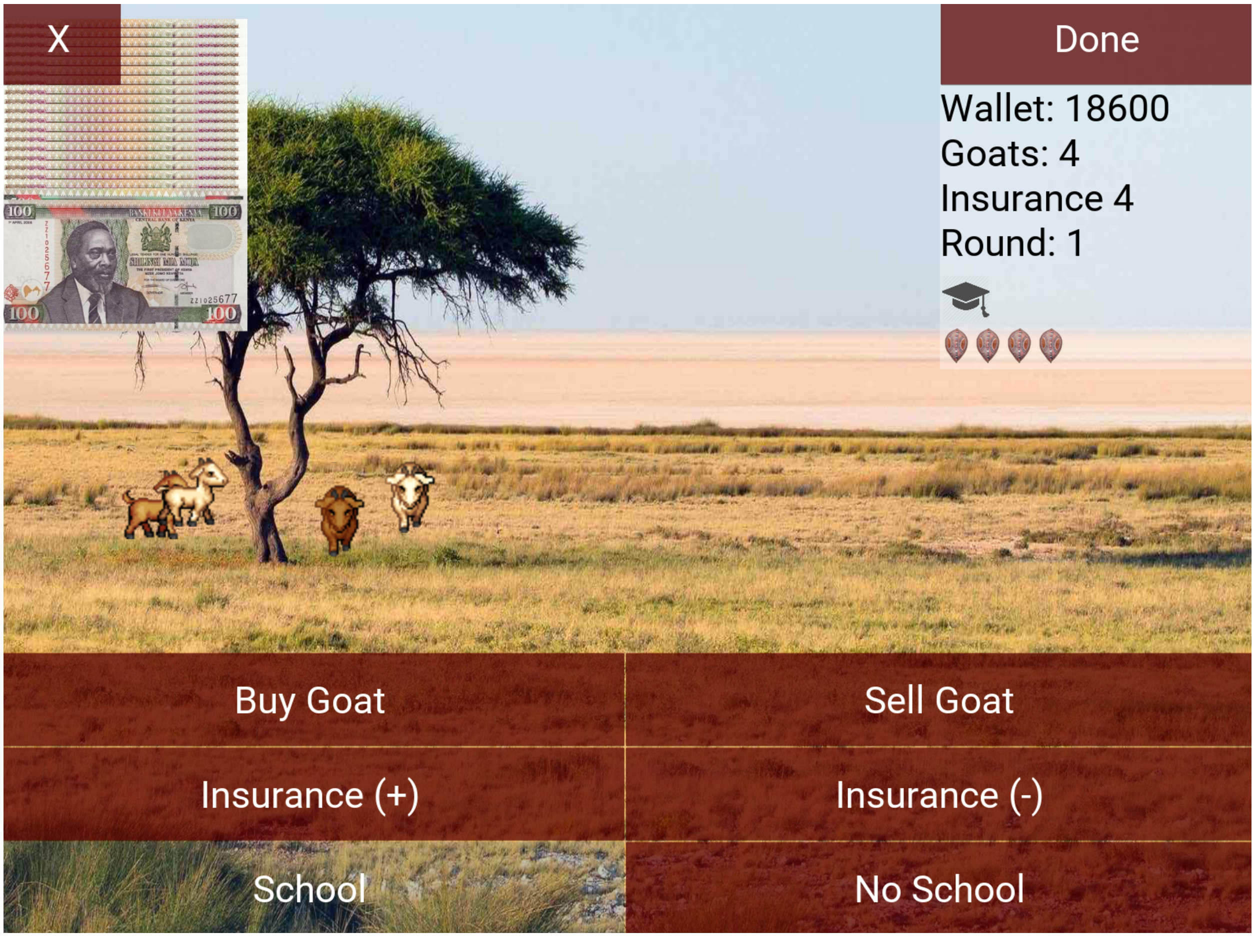

Figure 4: SimPastoralist

SimPastoralist

The SimPastoralist game makes it possible to collect rich data on decisionmaking by individuals and couples in a setting that mirrored the decisions they make in their daily lives. The game was developed over the course of several months at UC Davis, and was then intensively revised for several weeks with feedback from local pastoralists in Samburu. The probabilities, prices, and the insurance markup were all designed to match reality as closely as possible while keeping the game relatively simple.

Figure 4 depicts the gameplay screen from SimPastoralist. The shield icons represent the amount of insurance the player holds, and the graduation hat icon represents years of school. The wallet balance is shown both numerically and by adjusting the size of visible stack of cash on the left hand side of the screen. The enumerators explain all of these symbols to the players, and update them on their balances of cash, goats, and insurance before they finalize each decision and at the beginning of each round.

Because data collection is integrated into the game, it is possible to move through the game quickly. This increases participant engagement and allows participants to practice the game many times before they participate in the incentivized round. As a result, participants remained engaged, and many asked to stay longer to play more after the incentivized sessions were over. Participants also reported without prompting that they felt the game was educational and reflective of their lives. Based on those reactions, SimPastoralist has since been used for extension as well as data collection.

SimPastoralist is designed to mimic reality, but it differs from reality in one very important way: the player does not have the opportunity to choose consumption or withdraw money from the game until the end. Instead, consumption is fixed at a level designed to represent subsistence in each period, and the player gets to collect the full value of their cash and herd at the end of the game.

Goats reproduce with probability 2/3 in a good year and die with probility 2/3 in a bad year. The insurance premium is 350 KSh and it pays 1000 KSh in the event of a drought, so the net income from insurance is -350 in a good year and 650 in the event of a drought. This means that the insurance is slightly more expensive than actuarially fair - the markup was designed to be similar to the index insurance available in the region.

Every year each player also decides whether or not to send their children to school. School costs 2000 KSh, and six years of school are required for graduation. If the student graduated from school, the player earns a bonus of 10000 KSh at the end of the game. I had planned to test for variation in education spending between men and women, but in the data nearly 100% of participants of both genders chose to send their children to school until they graduated, meaning there is no significant variation.

The game can end in one of two ways. If the player does not have sufficient funds to pay the mandatory 5000 KSh for household consumption at the beginning of the round, the game ends early with a score of zero. Otherwise, the games ends at the tenth round. The final score is the sum of the value of the goats in their herd and the cash in their wallet, plus a bonus of 10000 KSh if their child finished school. The incentive is calculated so that every 500 KSh in the game translate into 1 KSh of real-world payment.

In the 'couples' version of the game, the rules are the same as above, with several important modifications. First, the initial budget is split between the two members of the household. Second, household members are given the option to split the cost of education/ consumption or allow one member to pay it entirely. Third, household members can transfer money to each other at any time and for any reason. This version of the game is used to study household preferences as distinct from individual preferences.

Experimental Design and Data Collection

The experimental sessions were conducted by four groups of enumerators who worked with roughly 8 couples per session[7] for a total of 387 couples. The couples were randomly selected from a larger sample of women who are participating in our randomized controlled trial of the BOMA REAP program. For that evaluation, women were selected randomly from a group screened by BOMA through a participatory process designed to identify the poorer households in each village.

In each session, we introduced the concepts in the game gradually. First, the enumerators performed a scripted skit situating the game. After seeing the skit, each player then played a version of the game without insurance twice. This was designed to introduce the part of the game that parallels life as they already experience it without the complication of insurance (insurance had not yet been introduced in the study region). The wife and husband

[7] The same number of couples were invited to each session, but in some cases a few did not show up.

alternated, with the person going first determined at random and selected by the tablet. The enumerators then performed another skit introducing the insurance version of the game, and each member of the couple played that game.

In half of the game sessions, we framed insurance using the traditional 'livestock' framing. Insurance is explained as a product designed to help the household replace or support livestock in the event of a drought. In the other half, we framed insurance as something the household could use **either** to support livestock or to pay for household expenses such as food, medical expenses, and school fees. The hypothesis, based on the theory above, is that women will buy more insurance under the household framing because it will increase their share of household income in the event of a drought.

After each player practiced the game without insurance twice and then with insurance twice, they were reminded that they were now playing the incentivized game. Only the data from the incentivized games are included in the analysis to follow.

After the individual games the 'couples' version of SimPastoralist is introduced. In that version, each partner begins with a smaller herd so that the total household budget is the same as in the original game. They are able to transfer money to each other at any time, and expenses can either be split of paid by one party.

Data

The SimPastoralist game yields a rich dataset. Data are recorded on every player decision, as well as the time it took them to make the decision. We began the game with a short survey on player characteristics, and are able to link the game data to the extensive survey data from the BOMA REAP evaluation.

We start players with a relatively small budget: enough to buy 12-18 goats. This corresponds to a herd size of less than 4 Total Livestock Units (TLU). In a non-game setting, herds this

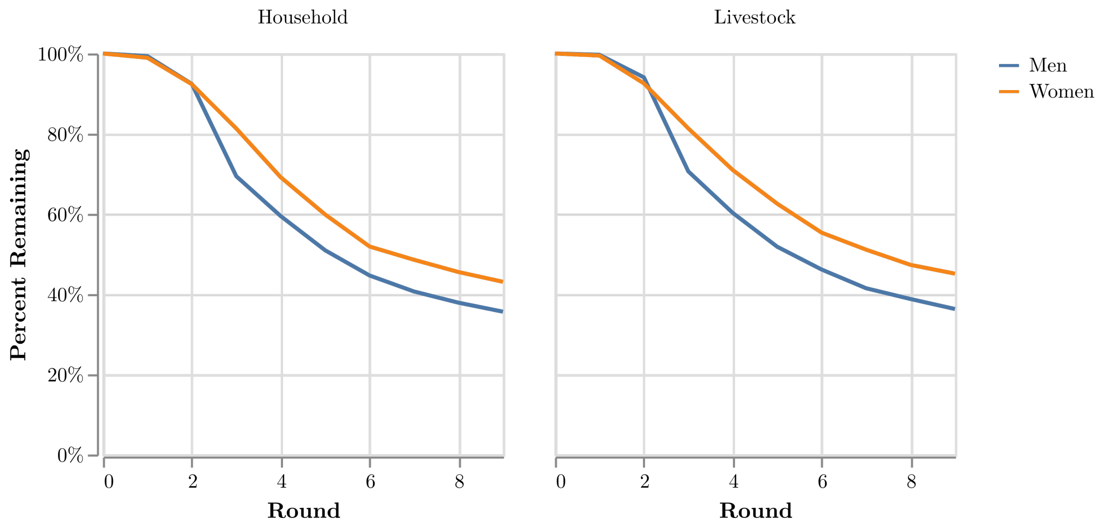

Figure 5: Survival rates were similar across framings, but a subset of men seem to systematically underperform women

small have been found to be below the Micawber Threshold, which is an asset level below which both theory and empirical evidence suggests households are more likely to fall into poverty.[8] One testament to the fact that SimPastoralist accurately approximated reality is that the results are consistent with the research on Micawber thresholds: participants who experienced good luck in the first few rounds so that their herds grew above the critical threshold tended to remain in play throughout the game, while others did not.

Figure 5 shows the percentage of players who remained in the game at the beginning of each round by gender. The game reflects the challenging dynamics of being a poor pastoralist: more than half of players did not last until the final round of the game. Attrition is fastest in the two rounds: by round 3, about 20% of women and 30% of men are already bankrupt. The difference in performance between women and men is consistent across framings of the game. While not the subject of this paper, it is worth noting that women seem to be more skilled on average at managing goats than men, at least in a simulated environment, despite the fact that it is not generally their role in the household.

[8]For discussion and evidence on Micawber thresholds in Northern Kenya see Janzen and Carter (2018) and Ikegami et al. (2017).

Measuring the Effect of Framing on Insurance Uptake

The theory above generates the hypothesis that insurance linked to household expenses will be more appealing to women than insurance linked to livestock. This section focuses on testing the impact of the household framing compared to the livestock framing, which represents current practice.

I examine two specifications: one to estimate the average effect of the household framing on units of insurance purchased and another to compare insurance demand as a function of budget levels in each framing. In both specifications, I pool the data from the individual and couples versions of the game. Partitioning the data and running the analysis on couples and individuals separately yields results that are qualitatively similar. In both specifications, women buy more insurance under the household framing. Further, some specifications suggest men buy less insurance under the household framing.

Average Treatment Effect

From the model above, we can see that the factors affecting decisions are the total budget, the round within the game t, and the individual's preferences. This leads naturally to estimating the equation

$$D_{it} = \beta_1 Treat_i Woman_i + \beta_2 Treat_i + \beta_3 Woman_i + \beta_4 Budget_{it} + \beta_5 Budget_{it}^2 + \gamma_t + \epsilon_{it}$$

where D_{it} is the dependent variable (goats or insurance), $Treat_i$ is a variable equal to 1 in the household framing, $Woman_i$ is a dummy variable equal to 1 when the respondent is a woman, and γ_t is a round fixed effect.

The key challenge in identifying the above equations is that the budget is endogenous after the first round, since preferences affect prior investment decisions which have some effect on future budgets. Fortunately, the design of the game provides a set of ideal instruments: the history of drought shocks that the player has experienced at time t and the starting budget.

The first stage of our instrumental variables estimation can be written

$$Budget_{it} = \sum_{i=1}^{t} \delta_t I_t FracGood_{it} + \sum_{i=1}^{t} \kappa_t I_t StartBudget_i + \text{controls} + \mu_{it}$$

where I_t is a year dummy, and the controls are the exogenous variables, and

$$FracGood_{it} = \frac{\sum_{j=1}^{t} \omega_{ij}}{t}$$

where ω_t is a dummy variable that is equal to 1 in the event of a good year and 0 in the event of a drought. In words, it represents the share of years that have been good for the pastoralist. The instrument is very strong: the first stage F-statistic is 53.75.[9]

We can estimate all three of these equations simultaneously: two equations for goats and insurance and one equation estimating the budget as a function of the instruments. In a two stage least squares framework the budget equation would be the first stage, but all three are estimated simultaneously in this case. Because the instrument was randomly generated by the tablet, I know for certain it is strictly exogenous and can use System Generalized Least Squares (GLS) rather than the Generalized Method of Moments to estimate the system of equations, which improves efficiency. Here I focus on the effect on demand for insurance; other regression results can be found in Appendix 1.

Figure 6 summarizes the regression results by plotting a confidence interval for the predicted insurance purchase at the average starting budget of 30,000 KSh. The household framing leads women to increase insurance purchase from 3.2 to 3.5 units on average, a 12.5% increase. Interestingly, it appears to reduce demand for men by about the same amount, though as

[9]This substantially exceeds the rule of thumb proposed by Staiger and Stock (1997), who find that first stage F-statistics less than 10 are likely to lead to weak instrument problems.

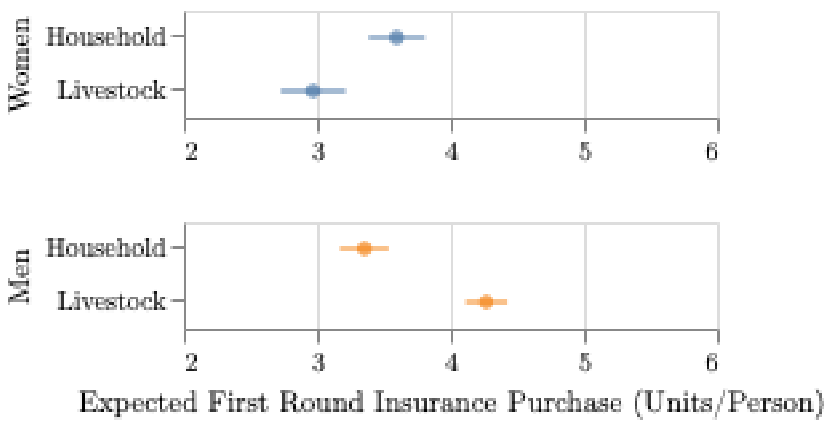

Figure 6: The household framing increases average insurance demand for women and reduces it for men

shown below this effect is no longer statistically significant when I estimate a more flexible specification that allows the treatment effect to depend on the budget. Detailed coefficient estimates are available in Appendix 1.

Variable Treatment Effect

In order to obtain more estimates that allow the treatment effect to vary with the budget, I estimate a regression similar to the above with an important modification: the 'Budget' variables are interacted with framing and gender variables so that the effect of the framing on demand can vary with the budget. This more flexible specification is a better fit for the theory, in which insurance demand is a function of budget. Due to the many interaction terms, the coefficient estimates are difficult to interpret and so I have relegated them to Appendix 1. Instead, I provide visualizations of predicted insurance purchase in each framing along with 95% confidence intervals.

As depicted in 7, these results are consistent with the average results above except that the effect of the household framing on men is no longer statistically significant. Further, the effect for women becomes statistically insignificant at high budgets. This makes sense given the theory: since household expenditures do not depend on the number of goats in the herd,

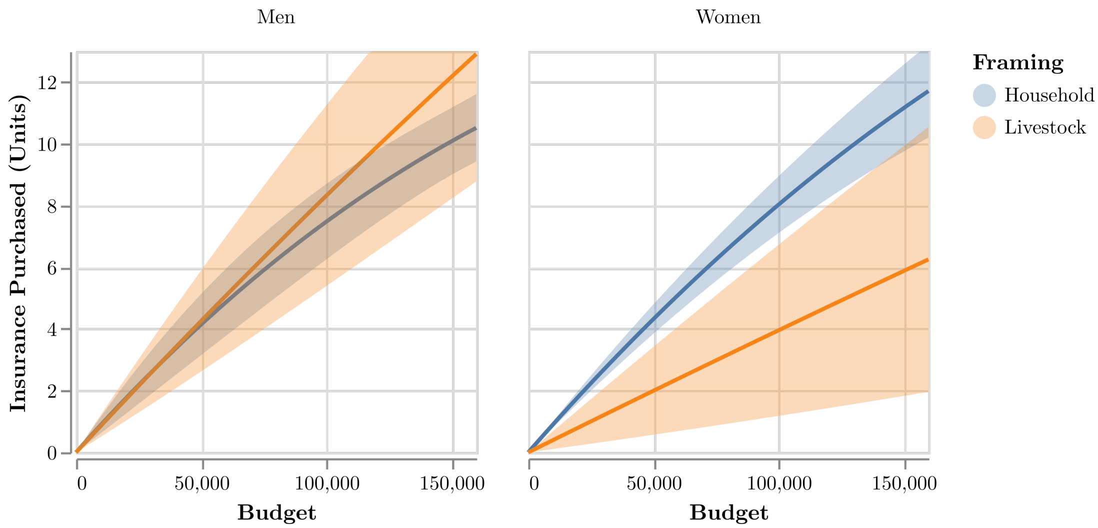

Figure 7: The household framing increases insurance demand for women and reduces it for men (robust standard errors)

they will play a smaller role in the quantity of insurance purchased as budgets grow.

Because treatment was randomized at the session level rather than the individual level, the results depicted in Figure 7 may underestimate standard errors.[10] As shown in Figure 8, clustering standard errors at the session level increases the size of the confidence intervals, which means that the effect of the treatment on demand is only statistically significant at the 95% level at very low budgets. Again, this is consistent with the theory: we would expect the household framing to make the largest difference when consumption expenses are highest relative to the size of the herd. Player budgets start between 25,000 and 35,000 KSh, so the graphic represents the range in which most of the data are found.

In general, these results suggest that the finding that the household framing increases demand by women is more robust than the finding that it decreases demand by men.

[10]According to Abadie et al. (2017), it is appropriate to cluster standard errors in this setting at the session level since that was the level at which the treatment was randomized.

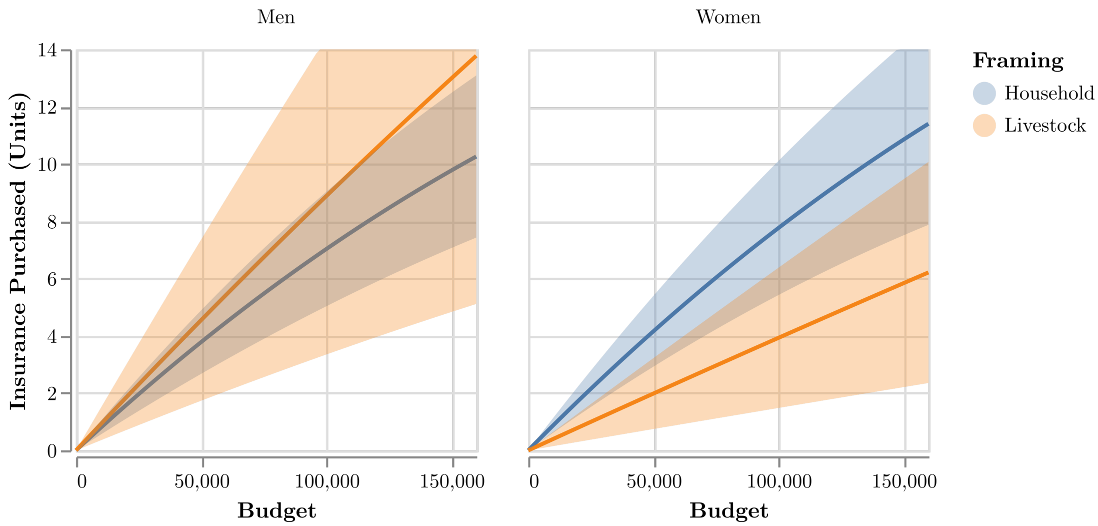

Figure 8: The household framing increases insurance demand for women and reduces it for men (clustered standard errors))

Conclusion

This paper set out to connect theory to the common empirical finding that women are disproportionately affected by droughts. The theory suggests that insuranced linked to household expenses could reduce that disparity. It argues that income in the event of negative shocks is especially valuable to women, but that the benefit of insurance tied to male-controlled assets is limited. A potential solution to this problem is to reframe insurance as a transfer to be used to pay for household expenses in the event of a drought. We tested this framing using a lab-in-the-field experiment in Samburu County, Kenya, and found that as the theory predicts, women bought more substantially more insurance when it was associated with household expenses.

The theory laid out in this paper also provides an explanation for two other empirically documented gender disparities. First, it explains why households appear to make productively inefficient investment decisions by underinvesting in women's plots relative to men's (see Udry (1996)). Second, it explains why grants given to women's businesses have smaller impacts on profits than grants to men's businesses when women are partnered, but not when they are single (see Bernhardt et al. (n.d.)). Of course, the fact that this theory can explain these results does not prove that it does; testing this linkage is a promising area for future research.

Our experiment made it possible to measure differences in demand, but not differences in the impact of household insurance. In order to test for differences in impact, household insurance must be tested in the field. The next step in this line of research is therefore to roll out household insurance in the real world to confirm that its greater popularity among women in an experimental setting translates into the real world.

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Appendix 1: Average Effect Regression Results

The following tables contain the full System GLS results from the joint estimation of equations for insurance, goats, and the 'first stage' equation that estimates budgets as a function of the instruments.

Insurance

The results below are the same as those included in the paper except I include coefficient estimates for the round fixed effects.

Table 1: Coefficient Estimates: Average Effects Regression

Variable	Coefficient	Std. Err.	T-stat	P-value	Lower CI	Upper CI
Round 0	2.1522	0.2202	9.7740	0.0000	1.7206	2.5837
Round 1	2.0404	0.2233	9.1385	0.0000	1.6028	2.4780
Round 2	2.0728	0.2412	8.5952	0.0000	1.6001	2.5454
Round 3	2.1078	0.2770	7.6104	0.0000	1.5649	2.6506
Round 4	2.2364	0.3393	6.5911	0.0000	1.5714	2.9015
Round 5	2.3612	0.3984	5.9262	0.0000	1.5803	3.1421
Round 6	2.1430	0.4757	4.5050	0.0000	1.2107	3.0753
Round 7	2.0909	0.5566	3.7569	0.0002	1.0001	3.1818
Round 8	2.1574	0.5126	4.2083	0.0000	1.1526	3.1622
Round 9	2.3446	0.7016	3.3417	0.0008	0.9695	3.7197
Household	-0.4374	0.2352	-1.8603	0.0628	-0.8983	0.0234
Female	-0.4593	0.2893	-1.5874	0.1124	-1.0264	0.1078
Household x Female	0.8030	0.3466	2.3167	0.0205	0.1237	1.4822
Budget	5.523e-05	8.01e-06	6.8950	0.0000	3.953e-05	7.093e-05
Budget^2	-1.69e-11	6.079e-12	-2.7808	0.0054	-2.882e-11	-4.99e-12

Budget

These results are equivalent to the 'first stage' in a two stage least squares regression. As shown below, the instruments individually are very significant: chance plays a major role in determining future budgets.

Table 2: Coefficient Estimates: First Stage

Variable	Coefficient	Std. Err.	T-stat	P-value
FracGood x Round 0 x StartBudget	0.5879	0.0006	999.44	0.0000
FracGood x Round 1 x StartBudget	0.8348	0.0005	1538.6	0.0000
FracGood x Round 2 x StartBudget	1.0362	0.0006	1659.9	0.0000
FracGood x Round 3 x StartBudget	1.2890	0.0008	1523.0	0.0000
FracGood x Round 4 x StartBudget	1.6090	0.0010	1538.3	0.0000
FracGood x Round 5 x StartBudget	2.0690	0.0011	1890.8	0.0000
FracGood x Round 6 x StartBudget	2.7623	0.0012	2215.9	0.0000
FracGood x Round 7 x StartBudget	3.7089	0.0014	2698.5	0.0000
FracGood x Round 8 x StartBudget	5.2575	0.0018	2874.8	0.0000
FracGood x Round 9 x StartBudget	7.2813	0.0006	1.233e+04	0.0000

Appendix 2: Variable Effect Regression Results

The following are the results from the OLS regression with robust standard errors used to create Figure 7.

Table 3: OLS Specification: Variable Effect Regression

Variable	Coefficient	Std. Err	z	p-value
Intercept	9.31e-10	2.69e-10	3.460	0.001
Round 1	-1.812e-08	9.12e-09	-1.986	0.047
Round 2	1.051e-08	4.79e-09	2.196	0.028
Round 3	2.573e-09	1.53e-09	1.684	0.092
Round 4	4.945e-09	3.31e-09	1.492	0.136
Round 5	1.062e-10	2.3e-11	4.625	0.000
Round 6	1.255e-10	2.08e-11	6.034	0.000
Round 7	1.362e-10	2.29e-11	5.950	0.000
Round 8	1.253e-10	2.34e-11	5.355	0.000
Round 9	1.168e-10	1.76e-11	6.657	0.000
Household	-2.076e-10	7.28e-10	-0.285	0.776
Female	4.472e-10	3.03e-10	1.478	0.139
Household x Female	8.374e-10	4.97e-10	1.685	0.092
Budget	8.717e-05	1.86e-05	4.679	0.000
Household x Budget	4.321e-06	2.38e-05	0.182	0.856
Female x Budget	-4.691e-05	2.38e-05	-1.967	0.049
Household x Female x Budget	4.808e-05	2.85e-05	1.685	0.092
Budget^2	-3.997e-11	4.98e-11	-0.802	0.423
Household x Budget^2	-1.389e-10	1.14e-10	-1.216	0.224
Female x Budget^2	3.265e-11	5.06e-11	0.645	0.519
Household x Female x Budget ^2	1.755e-11	1.17e-10	0.150	0.881
Budget^3	-3.828e-18	2.71e-17	-0.141	0.888
Household x Budget^3	1.158e-16	1.15e-16	1.003	0.316

Variable	Coefficient	Std. Err	z	p-value
Female x Budget^3	3.93e-18	2.74e-17	0.143	0.886

The following are the results with clustered standard errors, used to create Figure 8:

Table 4: CCluster Robust Specification: Variable Effect Regression

Variable	Coefficient	Std. Err	z	p-value
Intercept	9.31e-10	3.85e-10	2.418	0.016
Round 1	-1.812e-08	1.01e-08	-1.787	0.074
Round 2	1.051e-08	5.36e-09	1.961	0.050
Round 3	2.573e-09	1.78e-09	1.449	0.147
Round 4	4.945e-09	3.81e-09	1.299	0.194
Round 5	1.062e-10	3.33e-11	3.188	0.001
Round 6	1.255e-10	2.83e-11	4.429	0.000
Round 7	1.362e-10	2.89e-11	4.716	0.000
Round 8	1.253e-10	2.81e-11	4.454	0.000
Round 9	1.168e-10	2.52e-11	4.637	0.000
Household	-2.076e-10	9.26e-10	-0.224	0.823
Female	4.472e-10	3.42e-10	1.308	0.191
Household x Female	8.374e-10	5.36e-10	1.561	0.119
Budget	8.717e-05	2.57e-05	3.392	0.001
Household x Budget	4.321e-06	3.15e-05	0.137	0.891
Female x Budget	-4.691e-05	2.29e-05	-2.051	0.040
Household x Female x Budget	4.808e-05	3.08e-05	1.561	0.119
Budget^2	-3.997e-11	8.7e-12	-4.592	0.000

Variable	Coefficient	Std. Err	z	p-value
Household x Budget^2	-1.389e-10	1.11e-10	-1.251	0.211
Female x Budget^2	3.265e-11	7.27e-12	4.491	0.000
Household x Female x Budget ^2	1.755e-11	8.29e-11	0.212	0.832
Budget^3	-3.828e-18	2.7e-18	-1.416	0.157
Household x Budget^3	1.158e-16	9.09e-17	1.274	0.203
Female x Budget^3	3.93e-18	4.91e-18	0.801	0.423
Household x Female x Budget^3	-7.2e-17	7.41e-17	-0.972	0.331

1 Appendix 3: Scripts

The following are the scripts that were read by pairs of enumerators at the beginning of each session. Within each of the four teams, the same two enumerators held the roles in each session to minimize variation.

1.1 Household Framing

Woman 1: It has been a tough season - no rain at all. How is the drought affecting your family?

Kotogolo ana ng'amata meti nchan pii , aji eikunita nkolong'/lamei nkang' ino?

Woman 2: We lost half our goats and cattle and have been cutting back on meals because the goats that survived aren't producing much milk. It's going to be hard to pay school fees this year, and if the children have any medical expenses we will probably have to sell even more livestock.

Kotuata yio nkineji o nkishu, nomokure eta nkera ndaa, amaa amu meata ntare natelekunye naara kule. Kogolu abaki laata e skool e nkera, teneibisieng'u abaki nkera suom natelekunye *naake kimir .*

Woman 1: Have you heard about the new insurance that helps families in this kind of situation? It sends money to your M-Pesa account when droughts strike to help cover household expenses. We also lost half our goats and cattle, but at least we'll be able to pay school fees and buy food.

You can also buy insurance to help offset lost animals in the event of drought. You have to pay 500 KSh per goat in August, before the rainy season begins. If the rains are poor, they send 1000 Ksh for each goat to help revive your herd.

Itining'o ana ripet ng'ejuk naret nkang'ite ta mbaa/ramat natiwenyi? Kereu ropiyiani te simu(M-pesa) nkata e nkolong' payie eyasie ramat e nkaji. Kotuata yio ntare o nkishu, keikash naa amu kindim taa atalak ropiyiani e nkera e skool, nikindim sii ainy'angu ndaa

Woman 2: That sounds very helpful. How do I get this benefit?

Panijo kotuwua keretisho kulo omon. Aji aiko payie atum ana reto?

Woman 1: Well, it's not free – you have to pay a X KSh per family member in August, before the rainy season begins. If the rains are poor, they send 1000 Ksh for each person to help pay household expenses.

If you're interested, I can introduce you to the agent who sold us our insurance.

Maara taa pesheu, keyiari nilak ropiyiani X te ltung'ani obo le nkaji Ta lapa le esiet, eng'or ltumuren .tanaa etuesha aitibiraki nikirewakini 1000 te Ltung'ani obo le nkaji payie iasishere te ramat e nkaji. Tanaa iyieu,kaidim atirikoki ltung'ani otimiraka yio Inia ripet

Woman 2: Sounds interesting - I will speak to the agent to learn more.

Keining'o ajo keisupati kulo omon pii-kalo aiparishere ltung'ani omir ripet

1.2 Livestock Framing

Woman 1: It has been a tough season - no rain at all. How is the drought affecting your family?

Kotogolo ana ng'amata meti nchan pii , aji eikunita nkolong'/lamei nkang' ino?

Woman 2: We lost half our goats and cattle. It's going to be hard to pay school fees this year, and if the children have any medical expenses we will probably have to sell even more livestock.

Kotuata yio nkiteeng'ata e nkishu o nkineji.kogoliki yio laata e skool tale ari, o si tinimaniki ebisiong'u nkera, kuna kuni suom naatelekunye naake kimir alakie sipitali

Woman 1: Have you heard about the new insurance program? It sends money to your M-Pesa account when droughts strike. We also lost half our goats and cattle, but we'll be able to replace them using the insurance money.

Itining'o ana ripet ng'ejuk? Kereu ropiyiani te simu(M-pesa) nkata e nkolong'. Kotuata yio ntare o nkishu, keikash naa amu kindim taa ainyang'u nkule te nenia ropiyiani e ripet.

Woman 2: That sounds very helpful. How do I get this benefit?

Panijo kotuwua keretisho kulo omon. Aji aiko payie atum ana reto?

Woman 1: Well, it's not free – you have to pay a X KSh per goat or X*5 KSh per cow in August, before the rainy season begins. If the rains are poor, they send 1000 Ksh for each goat or 5000 KSh for cow to help revive your herd.

If you're interested, I can introduce you to the agent who sold us our insurance.

Maara taa pesheu, keyiari nilak ropiyiani X te nkine nabo o ropiyiani X te nkiteng' nabo Ta lapa le esiet, eng'or ltumuren.tanaa etuesha aitibiraki nikirewakini 1000 te nkine nabo o si 5000 te nkiteng' nabo payie iramatie mboo ino. Tanaa iyieu,kaidim atirikoki ltung'ani otimiraka yio Inia ripet

Woman 2: Sounds interesting - I will speak to the agent to learn more.

Keining'o ajo keisupati kulo omon pii-kalo aiparishere ltung'ani omir ripet

2 Appendix 4: Derivations

This appendix provides mathematical detail to back up the claims made in the body of the paper.

Since the problem is sequential and and has a finite horizon, it can be solved by working backwards. The overall decision sequence goes:

1. Man makes first period investment, transfer, and consumption decisions.
2. Woman makes first period investment, public goods, and consumption decisions.
3. Nature draws a random shock ϵ.
4. Man makes second period transfer and consumption decisions.
5. Woman makes second period public goods and consumption decisions.

We can begin with the final stage: the woman's second period decision (5). I write her utility function $u_w(c_w, z) = c_w^{\alpha_{cw}} z^{\alpha_{zw}}$. Her income, as before, is the sum of her production, insurance payments, and transfer. That means I can write her expenditure on consumption as:

$$c_w = \frac{\alpha_{cw}}{\alpha_{zw} + \alpha_{cw}}(f(k_w^1)\epsilon + t^2 + g(i^1, \epsilon))$$

and on public goods as:

$$z = \frac{\alpha_{zw}}{\alpha_{zw} + \alpha_{cw}}(f(k_w^1)\epsilon + t^2 + g(i^1, \epsilon))$$

With knowledge of these functions, and particularly of the formula for z, the man makes his decisions (4). The result that is important to our analysis is his choice of t^2, since it is the part of his decision that affects the wife's decision

$$t^2 = \min(\frac{\alpha_{zm} f(k_m)\epsilon - \alpha_{cm}(f(k_w)\epsilon + g(i^1, \epsilon))}{\alpha_{zm} + \alpha_{cm}}, \bar{t})$$

Given that result, we can write:

$$y_w^2 = \begin{cases} (f(k_w^1) + f(k_m^1) + g(i^1, \epsilon))\epsilon \frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}} & \text{if } t^2 \geq \bar{t} \\ f(k_w^1)\epsilon + g(i, \epsilon) & \text{otherwise} \end{cases}$$

Now we can consider the woman's investment decision in period 1. As discussed in the body of the paper (and apparent from examining the equation above), y_w is not concave in k_w. That means the first order conditions are not sufficient for a solution. However, they're still necessary, so it is useful to derive them.

The general condition can be written:

$$\frac{\partial u_w}{\partial z} = \beta E[\frac{\partial v_w}{\partial y_w^2} \frac{\partial y_w^2}{\partial k_w^1}]$$

Since the first order conditions are necessary but not sufficient, there are two possible solutions the first order condition: one corresponding to dependence and another in the case of indepence. For the dependent case, the first order condition is:

$$\frac{1}{y_w^1 - i^1 - k^1} = \beta E\left[\frac{f'(k_m^1)\epsilon \frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}}}{(f(k_w^1)\epsilon + f(k_m^1)\epsilon + g(i^1, \epsilon))\frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}}}\right]$$

and for the independent case:

$$\frac{1}{y_w^1 - i^1 - k^1} = \beta E\left[\frac{f'(k_m^1)\epsilon}{f(k_w^1)\epsilon + g(i^1, \epsilon) + \bar{t}}\right]$$

To analyze the role of risk and insurance, I focus on a scenario in which ϵ takes one of two values: ϵ_g in good years and ϵ_b in bad years, and that the probability of a bad year is p_b.

Because ϵ is the same for both the husband and wife, any investment decision absent insurance is associated with either dependence or independence regardless of the value ϵ takes. However, insurance makes it possible

In a good year, there is no insurance payout, so we have:

$$y_w^2 = \begin{cases} (f(k_w^1) + f(k_m^1))\epsilon_g \frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}} & \text{if } \frac{f(k_m)}{f(k_w)} > \frac{\alpha_{cm}}{\alpha_{zm}} \\ f(k_w^1)\epsilon_g & \text{otherwise} \end{cases}$$

In a bad year,

$$y_w^2 = \begin{cases} (f(k_w^1)\epsilon_b + f(k_m^1)\epsilon_b + \frac{i}{p_b}) \frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}} & \text{if } \frac{f(k_m)\epsilon_b}{f(k_w)\epsilon_b + \frac{i}{p_b}} > \frac{\alpha_{cm}}{\alpha_{zm}} \\ f(k_w^1)\epsilon_b + \frac{i}{p_b} & \text{otherwise} \end{cases}$$

As a result, insurance presents the option of choosing independence in bad states of the world and dependence in good states of the world. This is potentially very valuable, because the marginal return on investment is greater under independence than dependence. Add to this the standard value of insurance, which is based on the fact that the marginal utility of money is greater in bad states of the world, and insurance becomes particularly appealing for women who depend on transfers: insurance that induces independence yields more money per dollar spent *and* more utility per dollar earned than other investments.

In a similar way, insurance also increases the utility of capital investment by eliminating the tax in 'bad' states of the world. Insurance increases the woman's marginal product of capital in bad states of the world from $f'(k_w^1)\epsilon_b \frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}}$ to $f'(k_w^1)\epsilon_b \frac{\alpha_{zm}}{\alpha_{zm}+\alpha_{cm}}$.