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Abstract

We used a field experiment to investigate exchange asymmetries in productive assets among poor rural respondents in Ethiopia. Farmers were randomly allocated two types of productive assets or cash, with a choice to keep the productive asset (cash) or exchange it for cash (productive asset). To introduce productive asset variation, a durable asset (farm tool) and a short-term input (fertilizer) were randomly allocated and combined with a random amount of cash. Loss aversion was proxied with a separate experiment and was used to assess the importance of endowment effect theory to explain exchange asymmetries. A greater exchange asymmetry was found for the more popular tool than for fertilizer. Loss aversion could explain a small but significant part of the exchange asymmetry in tools, but experience did not reduce the exchange asymmetry. Compared to the female respondents, the male respondents exhibited greater exchange asymmetries and more non-linear price responses with declining elasticities as prices increased.

Key words: exchange asymmetry, endowment effect, loss aversion, factor markets, productive assets, input demand elasticities, field experiment.

JEL codes: D03, D51, O13, Q12

1. Introduction

Exchange asymmetries in individual decision-making have attracted substantial attention from economists since Thaler (1980) referred to the phenomenon that losses are weighted more heavily than gains as an "endowment effect" and related it to loss aversion and prospect theory. He saw it as a situation where people underweight opportunity costs. Samuelson and Zeckhauser (1988) use the term "status quo bias" as another explanatory concept for gain and loss asymmetry, whereas exchange asymmetries are also frequently identified in the form of a Willingness-to-pay (WTP) – Willingness-to-accept (WTA) gap, a term less loaded with causal explanation than "endowment effect" (Horowitz and McConnell 2002; Plott and Zeiler 2005). More recently, the prospect theory explanation of the phenomenon has been critically examined and questioned (Plott and Zeiler 2005; 2007; Brown 2005; Knetsch and Wong 2009; Morewedge et al. 2009). Plott and Zeiler (2005; 2007) demonstrated that exchange asymmetry could be reduced or eliminated by invoking a set of strict controls. They use this as a basis to refute the "endowment effects theory".

The aim of this study is to investigate whether exchange asymmetries in rural factor markets have behavioral explanations rather than material explanations in the form of high transaction costs, liquidity constraints, and information asymmetries. In light of new insights from behavioral economics, a basic question is whether we should abandon the "poor but efficient" hypothesis (Schultz 1965). Is low input demand due to loss aversion, status quo bias, procrastination and reluctance to invest rather than cash constraints and limited market access (Duflo, Kremer and Robinson 2011)? If this is the case, "nudging" and "commitment device" policies may be needed as additional development policies to promote such investments as input demand will remain inelastic even after removal of market constraints.

The specific objective of this study is to investigate the extent of exchange asymmetries for two types of productive assets versus cash among poor rural households through a field experiment where the physical market constraint and cash constraint are removed by requiring no out-of-pocket expenditure by the respondents. Although factor markets are known to be imperfect in rural areas in developing countries due to high transaction costs and imperfect information, less is known about the extent of residual exchange asymmetries after the removal of such basic transaction costs and information asymmetries. It has been shown that large asymmetries can occur

for lumpy input packages when respondents face cash constraints (Holden and Lunduka 2014) and that rural households may underinvest in highly profitable productive inputs (Duflo, Kremer and Robinson 2011). The issue is of high policy relevance because such exchange asymmetries may limit technology adoption and make the "nudging" of inputs more relevant than otherwise (Thaler and Sunstein 2008). The findings are also relevant to the debate regarding cash versus commodity transfers, which has most commonly focused on cash versus food transfers as in the Productive Safety Net Program in Ethiopia (Devereux et al. 2008). It is also relevant to the targeted input subsidy programs that have regained popularity in several African countries since 2005 (Dorward 2009). These programs focus on the targeted distribution of fertilizer and improved seeds at highly subsidized prices, with the aim of improving household and national food security. Exchange asymmetries can reduce crowding-out effects from such programs and thus reduce the probability that receivers of inputs will resell them for cash.

We use an incentive-compatible binary choice approach with a transparent random allocation of productive asset or cash. We randomize both the type of productive asset (tool versus fertilizer) and the amount of cash (40 EB-140 EB) that respondents are offered. The respondents decide only whether to keep the productive asset (cash) they have received or exchange it for cash (the productive asset). Before the actual experiments, we asked the respondents to give their preference ranking for the two productive assets (tool and small bag (6 kg) of fertilizer) and an amount of money (100 EB[1]). The small bag of fertilizer and the tool each have a market value of approximately 100 EB.

Most laboratory and field experiments that have investigated exchange asymmetries have used consumption goods such as mugs, pens, and chocolate bars with values of approximately 5 US$, each of which should be small enough not to invoke any significant income effects. One reason for the identification of significant exchange asymmetries for such commodities could be small differences in preferences between them (Plott and Smith 1978). Another explanation that has been proposed and often found to be of significance is the trade experience of the respondents. List

[1] EB = Ethiopian Birr; 100 EB = 5 US$ at the time of the experiments. This was also the market price for the two productive assets at the time of the experiments.

(2003; 2004) finds few or no exchange asymmetries for experienced traders and that increasing experience may reduce the asymmetry.

We used two types of assets that should be of productive value to the farm household respondents in our sample: fertilizer, which is a divisible and consumable productive asset; and a tool (plough, hoe or fork), which is a durable productive asset that is a necessary piece of equipment on their farm. The random variation in cash amounts implies a price variation from 40 to 140% of the market value for these productive assets (inputs). The experiment allows us to identify input price response elasticities while exchange asymmetries are observed as between-subject deviations between input demand and input supply curves. Exchange asymmetry is also detected econometrically by assessing the significance of a dummy variable for whether respondents first received the productive asset or the cash. The exchange asymmetry we detect could be due to a preference for cash over productive assets or vice versa; however, triangulation helps disentangle these relationships.

Rural farm households are used to buying consumable inputs such as fertilizers and seeds at least yearly, whereas tools such as those we use in the experiment are bought less frequently. We hypothesize, therefore, that we find a greater exchange asymmetry for tools than for fertilizer in our case when the typical transaction costs and immediate liquidity constraint are removed. Second, we hypothesize that loss aversion contributes to higher exchange asymmetry (endowment effect theory). Third, experience reduces exchange asymmetries and should be lower for men than for women, as men traditionally make agricultural decisions and are therefore more experienced. Fourth, we include preference rankings for the productive assets versus cash but do not have a particular hypothesis for how this affects the remaining exchange asymmetry. Stronger preferences may be associated with a stronger loss aversion, but near indifference may also cause more price-elastic responses. Finally, we derive demand and supply curves for a closer visual inspection of the supply and demand elasticities of the two commodities.

2. Theories and tests of exchange asymmetries

Thaler (1980) called the phenomenon that people may demand much more to give something up than they would be willing to pay to acquire it an *endowment effect*. Kahnemann and Tversky

(1984) attributed this asymmetry to *loss aversion*. Samuelson and Zeckhauser (1988) called the same phenomenon *status quo bias*.

The endowment effect has also been used as an explanation for the frequently found gap between willingness-to-pay (WTP) and willingness-to-accept (WTA) prices for the same good. Some attributed this gap to haggling behavior (Coursey, Hovis and Schultze 1987). Methodological developments in valuation methods took place in the following years, where the WTP-WTA gap remained strong in many studies; see Horowitz and McConnell (2003) for a review. Possible reasons for the WTA-WTP gap are income effects, transaction costs, ambiguity, haggling behavior, ownership feeling, and loss aversion (Brown 2005). Brown (ibid.) found evidence of loss aversion as a possible reason for the WTA-WTP gap.

Several experiments showed that the so-called endowment effects came almost instantly and that the effect was attributed to the pain of giving up something one owns, even if ownership has lasted for only a few seconds (Knetsch 1989; Kahnemann, Knetsch and Thaler 1991).

One alternative theory that has been investigated is whether the asymmetry is due to a lack of *trade experience*. Harbaugh, Krause and Vesterlund (2001) used simple exchange experiments on children without finding any effect of exchange experience. List (2003; 2004) tested for exchange asymmetries with field experiments. He found that exchange asymmetries varied across subject pools and suggested that this was due to variation in experience.

Another theory attributes asymmetry to the *characteristics of the good being traded*. The asymmetry may be less for everyday goods than for unique goods. List (2003, 2004) distinguished between unique goods and everyday consumables. He suggested that professional traders know their preferences better and that inexperienced traders may hesitate to trade (keep their good) due to their more limited experience. In the case of everyday consumable goods, less-experienced traders may also have more experience and thus are more likely to trade (less exchange asymmetry) and base their decisions on opportunity cost rather than loss aversion. Van Dijk and van Knippenberg (1998) tested exchange asymmetries related to the comparability of consumer goods.

They found a general reluctance to trade that was greater when the difference between two goods was greater.

Plott and Zeiler (2007) advanced and tested several alternative theories regarding endowment effects theory as explanations of exchange asymmetries. The alternative theories were related to experimental procedures, in addition to the trade experience theory already mentioned. First, *other-regarding preferences* may play a role as respondents may be reluctant to trade goods they received as gifts. Second, the *experimenters may influence* the respondents through the procedures in the experiments, such as through the language being used or other signals given. Third, public revelation of responses may cause respondents to influence each other (*cascade theory*). Fourth, *small differences in transaction costs* may make a difference when respondents are nearly indifferent regarding their choice of commodities. Plott and Zeiler (2007) designed experiments to test these alternative theories alone and in combination. They found that when combining the additional controls, the exchange asymmetry disappeared. They did not find that small differences in transaction costs mattered but instead were a weak indication of cascade (signaling) effects. They attributed the lack of specificity of the findings to interaction effects between possible alternative explanations but concluded that they could reject endowment effects theory as an explanation of the asymmetry.

Morewedge et al. (2009) found that ownership and not loss aversion could explain the endowment effect. They found that the endowment effect disappeared when buyers were owners and when sellers were not. Knetsch and Wong (2009), building on the model of reference-dependent preferences by Köszegi and Rabin (2006), noted that status quo may not always be the obvious reference point and conducted an experiment that demonstrated that reference point and not ownership explains the endowment effect.

We may question why endowment effects should exist for commodities that provide little attachment value for the owners. Why should a mug or a pen have such an intrinsic value that loss aversion makes a difference? The mug or pen must then be very special and be associated with an institution or event of particular importance to the owner. Endowments must also be of substantial size to give a visible income or wealth effect. A cash constraint may be another reason for an

exchange asymmetry and may cause inelastic or low demand. We designed an experiment that allows testing for exchange asymmetries in productive assets, where we control for cash and income effects. The details of the experiment are outlined in the next section.

3. Experimental design and theoretical concerns

The participants in the experiment were male heads and the spouses (or female heads) of households that participated in a household survey in 2012. Participation in the experiment was part of a reward for having spent a significant amount of time in survey interviews. They could therefore be considered to have earned the outcome they would obtain in the experiment; they were informed about this in advance of participating in the experiment.

The experiment was set up to first elicit the preference ordering of the respondents. What each respondent received was then determined through coin tosses, first, to determine whether the commodity was a tool or a small bag of fertilizer, and second, to determine whether they would first receive the commodity or a random amount of cash. The random amount of cash for each player was identified in advance through a random number generator in the range 40 to 140 EB. After this commodity or cash outcome was identified, they had one chance to exchange the lottery outcome for cash if the outcome was the commodity, and vice versa. The commodity and cash were placed in front of them so that they could see what they would potentially obtain. They decided to keep or exchange without any follow-up questions.

An eventual exchange asymmetry is identified based on between-subject comparison of the responses. The experiment also allows identifying price response elasticities and allows control for preference order. It allows testing of the difference between a durable lumpy productive asset (tool) and one that provides a short-term return through use and is divisible (fertilizer). One may tentatively expect a higher "endowment effect" or exchange asymmetry for durable and lumpy assets than for non-durable and divisible assets. One may also expect a higher exchange asymmetry or "endowment effect" for more preferred assets. This is what we tested.

The experiment is conducted with the husband and the wife of a household without either knowing the preference order, random outcome, or choice of their spouse. After both have participated, one

of their choice outcomes will be randomly chosen as the real outcome based on another coin toss. The procedure and form used are presented in Appendix 1.

A separate experiment was conducted to elicit an indicator for the respondents' loss aversion or risk aversion. The format for this experiment in presented in Appendix 2.

a) The field experiment is designed to test for some possible reasons for exchange asymmetries while it attempts to eliminate or minimize other potential reasons for such asymmetries. These relationships are summarized as follows. Endowment effect theory: A measure of loss aversion is elicited as a loss aversion rank. Although this measure is not independent of risk aversion, it should capture whether loss aversion matters for observed exchange asymmetries. The endowment (tool, fertilizer or cash) is allocated through a lottery (coin tosses) and is won with a probability of 50% for spouses, whereas another coin toss determines the final outcome for the household after each of the spouses has decided whether to keep or exchange what s/he has been randomly allocated.
b) Trade experience: This is investigated by assessing the significance of certain respondent characteristics (gender, age, education, and market participation in factor markets). More experienced and educated respondents should exhibit less exchange asymmetry. Men are traditionally responsible for agricultural decisions, but women have more recently been allocated stronger land rights; this may have contributed to involving them more in input decisions. However, men are still expected to be more experienced.
c) Nature of the good: A more frequently purchased input (fertilizer) and a less frequently purchased durable asset (tool). More-traded assets should exhibit smaller exchange asymmetry. We therefore expect a lower exchange asymmetry for fertilizer than for the tool.
d) Transaction cost theory: We placed the productive assets and the cash in front of the respondents so that they could observe them and have them within reach. The respondents need make only one decision and respond 1 = Keep or 2 = Exchange. We also used two types of productive assets that should be of significant value to the agricultural households that constitute the sample population. We also asked them to rank their preference order

for the tool, fertilizer and a cash amount of 100 EB, a value that is equivalent to the market value of the inputs.

e) Other-regarding preferences: The benefit obtained in the experiment is earned through participation in repeated surveys where both husbands and wives were exposed to lengthy interviews and were equally worthy of compensation for this participation. The random allocation of the tool or fertilizer and of commodity versus cash through two coin tosses should prevent value judgment influences from the experimenter to the respondents in the form of "gift allocation".

f) Experimenter influence: The use of random allocation mechanisms (i.e., coin tosses) prevented beliefs that allocations are based on experimenters' value judgments.

g) Cascade theory: The respondents are isolated from the other respondents when they make their decisions (privacy) and do not know what decisions others made in the experiments when they make their own decision.

If significant exchange asymmetries are found after these controls are imposed and input demands are still highly inelastic, there may be reasons to suspect that household preferences and not only market constraints explain low input demand levels.

4. Data and estimation strategy

Most studies of endowment effects theory and exchange asymmetries have used relatively small samples and simple paired comparison techniques to test the relevant hypotheses. Plott and Zeiler (2007) fail to identify a clear combination of factors other than endowment effects theory to explain exchange asymmetries. We benefit from having a somewhat greater sample and a design that helps us elicit price responses. Our data allow us to test for the relevance of endowment effects theory by the inclusion of data from a simple loss aversion experiment, test for correlation with experience-related variables, test for commodity differences, control for single versus paired respondents (having certain or probabilistic outcomes of their choices), and assess gender differences, price response elasticities, and preference rankings. We estimate these in a stepwise approach starting with simple models. We start with the following simple aggregate model:

1) $$\pi_{ih} = \alpha_0 + \alpha_1 \lambda_{ih} + \alpha_2 D_C + \alpha_3 D_T + \alpha_4 D_C * D_T + \alpha_5 M + e_{ih}$$

The dependent variable takes value = 1 if the respondent chooses the commodity and value = 0 if s/he chooses cash. λ_{ih} is a variable capturing loss aversion rank (ranked from 1 to 7, with 7 indicating the highest level of loss aversion) from the loss aversion experiment.[2] D_C is a dummy variable = 1 if the respondent receives the commodity (productive asset) first, and zero otherwise. D_T is a dummy variable = 1 if the commodity is a tool, and zero otherwise. M is the random amount of cash that varied from 40 EB to 140 EB, and e_{ih} is the error term. This model allows us to test for the potential importance of endowment effect theory with the loss aversion rank variable. We run models with and without this variable and models with and without the interaction variable between being a commodity receiver and the commodity being a tool. The commodity receiver dummy tests for a general exchange asymmetry, which could be due to a commodity versus cash asymmetry. The tool dummy tests for whether the exchange asymmetry is different for the tool versus fertilizer, and the interaction variable tests whether receiving the tool first has an additional effect on the exchange asymmetry.

Next, we want to test the importance of experience by including a range of household and respondent variables that should signify such experience and assess their effects on the extent of exchange asymmetry. We also include a dummy variable for single respondent households as they know with certainty that they will get their choice, whereas respondents from households with two respondents have only a probabilistic expectation of receiving their choice because only one of them will obtain it (based on a coin toss). Furthermore, we assess whether the price response can be non-linear by including a quadratic representation of the random cash amount (price) received/offered (see equation 2):

$$2) \quad \pi_{ih} = \alpha_0 + \alpha_1\lambda_{ih} + \alpha_2 D_C + \alpha_3 D_T + \alpha_4 D_C * D_T + \alpha_5 M + \alpha_6 \left(M^2/1000\right) + \alpha_7 D_{Sh} + \alpha_8 E_{ih} + e_{ih}$$

E_{ih} represents a vector of experience-related variables including the sex of the respondent; the age, education and farm experience of the household head; and a dummy for the household head being female. Men are usually responsible for agricultural decisions in Ethiopia and may therefore be considered more experienced than women. Female-headed households often rent out their land rather than farm it themselves. D_{Sh} is a dummy for households with only a single respondent who received their choices with certainty.

[2] See the Appendix for details on the loss aversion experiment.

To explore further commodity and gender differences, disaggregated models are run for the tool and fertilizer and for the male and female respondents. These models are run with the same RHS variables as specified above.

The preference ranking of commodities versus cash may affect the extent of exchange asymmetry and price responses. Preference rankings may also be a consequence of loss aversion and expected future returns from the productive assets as well as of perceived risks. Preference for cash rather than productive assets may be due to the need for cash for consumption or other purposes. The rank order for tool, fertilizer and 100 EB was included in models to assess its significance for the exchange asymmetries.[3] Rank = 1 is first priority, rank = 2 is second priority and rank = 3 is third priority. We expect loss aversion to be more important for more-preferred commodities. The preference ranks are presented in Appendix 2, Table A2.1.

To allow closer inspection of the disaggregated exchange asymmetries and non-linear price responses by commodity type and gender, we generate graphical non-parametric estimates (fractional-polynomial prediction plots with 95% confidence intervals) of input demand and input supply curves in the price and probability space. Supply curves show the estimated price response probability of commodity receivers, whereas demand curves show price response probabilities of cash receivers.

5. Descriptive statistics

Table 1 provides an overview of the experiments: tool versus cash and fertilizer versus cash. There is a significant exchange asymmetry for both types of productive assets. The exchange asymmetry, observed as the percentage gap between commodity receivers and cash receivers, appears to be substantially greater for the tool than for fertilizer.

Table 2 gives an overview of the main variables used in the analysis. Approximately 52% of the respondents were male, and approximately 12% of the households had only one respondent who

[3] Only two out of three rank orders are needed to determine the order fully.

participated and who therefore knew with certainty that s/he would obtain her/his choice. The average cash preference rank and tool preference rank were close to equal, whereas fertilizer was less preferred by the majority of respondents. This was surprising given that the timing of the experiment was close to the beginning of the rainy season. A more detailed preference ranking by gender is given in Appendix 2, Table A2.1.

Table 1. Overview of experimental outcomes and choices

	Initial endowment is commodity	% choose commodity	Initial endowment is cash	% choose commodity
Tool versus Cash	258	62.8	302	35.8
Fertilizer versus Cash	261	26.4	221	15.8

Note: Pearson chi2(1) = 40.71, Pr. = 0.000 for tool versus cash experiment. Pearson chi2(1) = 7.95, Pr. = 0.005 for fertilizer versus cash experiment.

Table 2. Overview of key variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Choose commodity, dummy	1042	.359	.480	0	1
Commodity receiver, dummy	1042	.498	.500	0	1
Commodity is tool, dummy	1047	.537	.499	0	1
Random cash amount, EB	1044	91.03	30.34	40	140
Loss aversion rank	1031	2.66	2.51	0	7
Sex of respondent, male = 1	1047	.516	.500	0	1
Female-headed, dummy	1047	.037	.189	0	1
Age of head of household	976	48.45	14.88	23	99
Education of household head	976	3.54	3.67	0	15
Farm experience of head, years	975	29.58	14.63	0	80
Single respondent household	1047	.116	.320	0	1
Tool preference rank	1047	1.73	.702	1	3
Fertilizer preference rank	1047	2.56	.633	1	3
Cash reference rank	1047	1.71	.796	1	3

6. Results and discussion

Table 3 presents the results for the models specified in equation 1. The models are linear probability models with cluster-robust standard errors, clustering at the community level. Model c1 includes a dummy for commodity receiver and a dummy for commodity being tool. The first of these is a basic test for exchange asymmetry; it is highly significant (at the 0.1% level of significance), with commodity receivers being 19% more likely to choose commodity than cash receivers. Because the dummy for tool is included, the dummy for commodity receiver captures the exchange asymmetry for fertilizer versus cash. The fact that the dummy for tool is also highly significant (at the 0.1% level) and positive demonstrates that the exchange asymmetry is significantly greater for the tool than for the fertilizer versus cash, with the tool receivers being approximately 46% more likely to choose the tool than cash receivers are to choose the tool. Model c2 shows that there is a significant positive interaction effect between receiving a commodity and the commodity being a tool. We also see that there is a highly significant (at the 0.1% level) price response, with input price elasticity of approximately -0.4 at the mean, which is an inelastic response. Models c3 and c4 include the loss-aversion rank variable, which is significantly positive at the 1% level in both models. This indicates that loss aversion is significantly related to a higher probability of choosing commodity rather than cash. Its inclusion leads to a slight but not strong reduction in the dummy variables capturing exchange asymmetries. This may be interpreted as evidence that loss aversion contributes to the exchange asymmetry but only to a rather limited extent. We can therefore not rule out endowment effect theory but need to search for other explanations as well.

Table 3. Test for exchange asymmetries and importance of loss aversion

	c1	c2	c3	c4
Loss aversion rank			0.018***	0.018***
			(0.01)	(0.01)
Dummy for commodity receiver	0.190****	0.109**	0.184****	0.103**
	(0.04)	(0.04)	(0.04)	(0.04)
Dummy for commodity = tool	0.267****	0.192***	0.263****	0.187***
	(0.05)	(0.05)	(0.05)	(0.05)
Commodity receiver*Tool		0.149***		0.150***
		(0.04)		(0.05)
Random cash amount received	-0.004****	-0.004****	-0.004****	-0.004****
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	0.490****	0.531****	0.448****	0.489****
	(0.06)	(0.06)	(0.06)	(0.06)
Prob. > chi2	0.000	0.000	0.000	0.000
R-squared	0.181	0.187	0.189	0.195
Number of observations	1023	1023	1023	1023

Note: OLS models with cluster-robust standard errors with clustering at the village level. Standard errors in parentheses. Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.01%.

In Table 4, we include a set of variables that should capture the experience and education of the respondents and their household heads. However, none of these variables is significant. The dummy for single respondent households is also not significant. The fact that these respondents knew with certainty that they would obtain their choice and that other respondents faced a probability of 0.5 of obtaining their choice, appears not to have affected their choices significantly. The probabilistic winning outcome was sufficient to create a highly significant exchange asymmetry. The design of the experiment with probabilistic outcomes should imply that experimenters' value judgments had no significant effect on these outcomes. However, we cannot rule out the effects of perceptions such as lottery outcomes being the outcome of "God's will"; therefore, this creates a psychological transaction cost and hesitance to change the outcome.

Table 4. Exchange asymmetry testing for the effect of experience, single respondent and non-linear price response

	m1	m2	m3
Loss aversion rank	0.018***	0.018***	0.018***
	(0.005)	(0.006)	(0.005)
Dummy for commodity receiver	0.103**	0.102**	0.102**
	(0.040)	(0.039)	(0.039)
Dummy for commodity = tool	0.198***	0.197***	0.194***
	(0.051)	(0.050)	(0.050)
Commodity receiver*Tool	0.143***	0.144***	0.152***
	(0.047)	(0.047)	(0.047)
Random cash amount received	-0.004****	-0.004****	-0.015****
	(0.000)	(0.000)	(0.003)
Random cash squared / 1000			0.064***
			(0.017)
Single respondent, dummy		0.015	0.014
		(0.057)	(0.054)
Sex of respondent, 1 = male	0.035	0.033	0.029
	(0.041)	(0.040)	(0.039)
Female headed dummy	0.054	0.040	0.050
	(0.067)	(0.091)	(0.089)
Age of household head	0.001	0.001	0.001
	(0.001)	(0.001)	(0.002)
Education of household head	0.003	0.003	0.003
	(0.004)	(0.004)	(0.005)
Farm experience of head, years	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.002)
Constant	0.451****	0.451****	0.899****
	(0.081)	(0.081)	(0.153)
Prob. > chi2	0.000	0.000	0.000
R-squared	0.198	0.198	0.212
Number of observations	952	952	952

Note: Linear probability (OLS) models with cluster-robust standard errors with clustering at the village level. Standard errors in parentheses. Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.01%.

We found that the quadratic form of the price response is significant at the 1% level in model m3 and resulted in a change in the linear response being more elastic initially but at a declining rate. We return to these elasticities with the non-parametric graphical estimates below. We see that the loss-aversion effect and other variables are stable with the inclusion of the new variables.

The disaggregated analysis by commodity and gender is presented in Table 5, where the first two models show results after disaggregation by commodity.

Table 5. Test for exchange asymmetries disaggregated by commodity type and gender of respondent

	Disaggregation by commodity		Disaggregation by gender	
	Tool	Fertilizer	Men	Women
Loss aversion rank	0.026**	0.008	0.021***	0.013
	(0.009)	(0.007)	(0.006)	(0.008)
Dummy for commodity receiver	0.256****	0.107**	0.217****	0.157***
	(0.049)	(0.038)	(0.044)	(0.054)
Dummy for commodity = tool			0.304****	0.236***
			(0.048)	(0.064)
Random cash amount received	-0.012***	-0.020****	-0.020****	-0.010*
	(0.004)	(0.004)	(0.003)	(0.005)
Random cash squared / 1000	0.046**	0.090***	0.088****	0.035
	(0.020)	(0.024)	(0.017)	(0.026)
Sex of respondent, 1 = male	0.066	-0.016		
	(0.057)	(0.034)		
Female headed dummy	0.082	-0.003		0.022
	(0.116)	(0.103)		(0.107)
Age of household head	0.001	-0.000	-0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.003)
Education of household head	-0.003	0.013	0.007	0.001
	(0.006)	(0.008)	(0.007)	(0.004)
Farm experience of head, years	-0.002	0.000	0.002	-0.004
	(0.002)	(0.002)	(0.001)	(0.003)
Single respondent household	0.027	-0.005	0.019	0.004
	(0.063)	(0.081)	(0.058)	(0.098)
Constant	0.916****	1.119****	0.985****	0.732**
	(0.195)	(0.246)	(0.150)	(0.256)
Prob. > chi2	0.000	0.000	0.000	0.000
R-squared	0.154	0.155	0.251	0.172
Number of observations	526	426	489	463

Note: Linear probability (OLS) models with cluster-robust standard errors with clustering at the village level. Standard errors in parentheses. Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.01%.

We already observed that the exchange asymmetry is substantially greater for the tool than for fertilizer. This is also evident in Table 5, where the dummy for commodity receiver is associated

with a 25.6% higher likelihood of choosing the tool when the commodity is a tool compared with a 10.7% higher likelihood of choosing fertilizer when fertilizer is the commodity. We see significant non-linear price responses for both commodities, but loss aversion remains significant (at the 5% level) in only the model for the tool.

Examining gender-disaggregated models showed some striking differences that were hidden when we included only the dummy variable for the sex of the respondent in previous aggregated models. Males appear to demonstrate larger exchange asymmetries as the parameters on the dummy variables for commodity receiver and the commodity being a tool are greater (and more significant) than for women. This could be because men are traditionally responsible for farming decisions in Ethiopia and value these productive inputs more.

The fact that the loss aversion rank variable remains significantly positive at the 1% level for men indicates that a loss perception could contribute to greater parameters for the fertilizer and the tool. The market experience of the men seems not to eliminate this effect, but the men do respond much more strongly to price signals than do the women. Both the linear and quadratic price variables are highly significant (at the 0.1% level) for the men, but only the linear effect is significant at the 10% level for the women. However, removing the quadratic price variable for the women reveals that the linear effect is highly significant (at the 0.1% level). The main difference between the men and women is therefore the non-linear price response of the men, where they show a more elastic price response at low prices and an inelastic response at higher prices. This will be evident in the graphical output that is presented below.

We found that loss aversion is significantly associated with the tool and with men's choices. This could partly be because this variable was obtained by running the experiment with household heads, who are men in most cases. We therefore do not have a measure of the loss aversion of the female spouses who did not participate in the loss aversion experiment. However, we have their preference rankings for the tool versus 6 kg fertilizer versus 100 EB. Table 6 reports the estimation results with these preference rankings included in the models, disaggregated by commodity and gender. We dropped the household level variables as they were insignificant in the previous models and caused loss of some observations due to missing data.

Table 6 demonstrates that preference rankings have a substantial effect on the choices made by the respondents. The model for tool shows that that a one-rank position change for tool is associated with a 15.6% change in the probability that the tool is preferred, whereas a one-rank position change in the position of cash changes the probability that cash is chosen by 11.2% at the mean. We also see that loss aversion has become insignificant. It is likely that the loss aversion effect is coming through the tool preference-ranking variable.[4] The fertilizer preference rank is not significantly related to the choice of fertilizer over cash, but a stronger cash preference by one ranking unit is associated with a 16.1%-reduced likelihood that fertilizer is chosen. Both the tool and cash show significant non-linear price responses after controlling for preference ranking.

In models disaggregated by gender, the loss aversion variable remains significant at the 1% level after the inclusion of commodity preference variables for men. The pattern, with a tendency for stronger exchange asymmetries for men than for women, a non-linear price response for the men and a more-linear response for the women, is similar to that in Table 5. The cash-rank variable is significant at least at the 1% level in all models for the men as well as for the women, whereas the tool-rank variable is less significant. This pulls us in the direction of questioning whether demand for cash can also contribute to the exchange asymmetry for households that are initially allocated cash. The demand for cash rather than productive assets may be caused by immediate consumption needs and impatience and explain low input demand. The benefit stream from the tool is more long-term, whereas the fertilizer yields more intermediate returns. We were unable to eliminate the observed exchange asymmetries by eliminating the factor market transaction costs by providing the inputs at the farm gate. This shows that direct provision of productive assets can enhance investments, whereas to a lesser extent, provision of cash leads to productive investments. We cannot claim that such responses are irrational because we do not have information regarding what cash-preferring respondents would like to purchase with the cash. It is even possible that they

[4] We investigated this in a separate regression of commodity preference rankings on loss aversion and other household characteristics (see Appendix 2, Table A2.2). We note a significant correlation between tool preference ranking and loss aversion; higher loss aversion is associated with the tool being more preferred. The men also have a significantly stronger preference for the tool than do the women. Loss aversion was significantly correlated with a lower preference for cash, whereas the women had a significantly stronger preference for cash than did the men.

have other investment options in mind. However, the demand may also be related to satisfaction of more immediate basic needs.

Table 6. Disaggregated models with preference rank variables

	Tool	Fertilizer	Men	Women
Loss aversion rank	0.013	0.007	0.017***	0.004
	(0.008)	(0.007)	(0.006)	(0.006)
Dummy for commodity receiver	0.260****	0.105**	0.216****	0.153**
	(0.047)	(0.038)	(0.040)	(0.054)
Dummy for commodity = tool			0.277****	0.209***
			(0.050)	(0.058)
Random cash amount received	-0.011***	-0.018****	-0.019****	-0.009**
	(0.003)	(0.003)	(0.003)	(0.004)
Random cash squared / 1000	0.041**	0.078****	0.085****	0.027
	(0.018)	(0.018)	(0.017)	(0.021)
Tool preference rank	-0.156***		-0.050	-0.066*
	(0.041)		(0.038)	(0.037)
Cash preference rank	0.112***	0.161****	0.152***	0.162****
	(0.034)	(0.023)	(0.045)	(0.031)
Fertilizer preference rank		-0.042		
		(0.029)		
Constant	1.042****	0.904****	0.835****	0.574**
	(0.220)	(0.200)	(0.170)	(0.219)
Prob. > chi2	0.000	0.000	0.000	0.000
R-squared	0.283	0.245	0.338	0.273
Number of observations	554	469	529	494

Note: Linear probability (OLS) models with cluster-robust standard errors with clustering at the village level. Standard errors in parentheses. Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.01%.

We will now examine the non-parametric graphical supply and demand responses for tool and fertilizer. In Figures 1 and 2, we illustrate the input demand and supply curves in price and probability space, where demands for input (tool or fertilizer) are estimated for receivers (winners)

of cash and where input supplies are estimated for receivers (winners) of the commodity as probabilities that they will trade these when prices change. These are estimated using fractional response models in Stata 13. The graphs include 95% confidence intervals for the curves.

Figure 1 shows that 75% of the receivers of cash purchase the tool at the lowest price of 40EB, whereas fewer than 20% of the receivers of the tool sell the tool at this price. At a price of 60 EB, approximately 50% of the receivers of cash purchase the tool, whereas approximately 30-35% of tool receivers sell the tool, etc. With no exchange asymmetry, the supply and demand curves should cross each other where the probability of exchange is 50%. The crossing point for the demand and supply curves is where the probability of exchange is below 40% and at a price below 80EB, well below the market price of 100 EB. However, the supply curve does not reach even a 50% chance of selling the tool when the selling price is 140 EB. The non-linearity of supply and demand is evident with high elasticities at low prices but very low elasticities at higher prices. A substantial share (>50%) of the tool receivers are not willing to sell the tool even at a very high price (>40% above market price), whereas approximately 20% of the cash receivers are willing to buy the tool at this price. The asymmetry is therefore stronger at high prices.

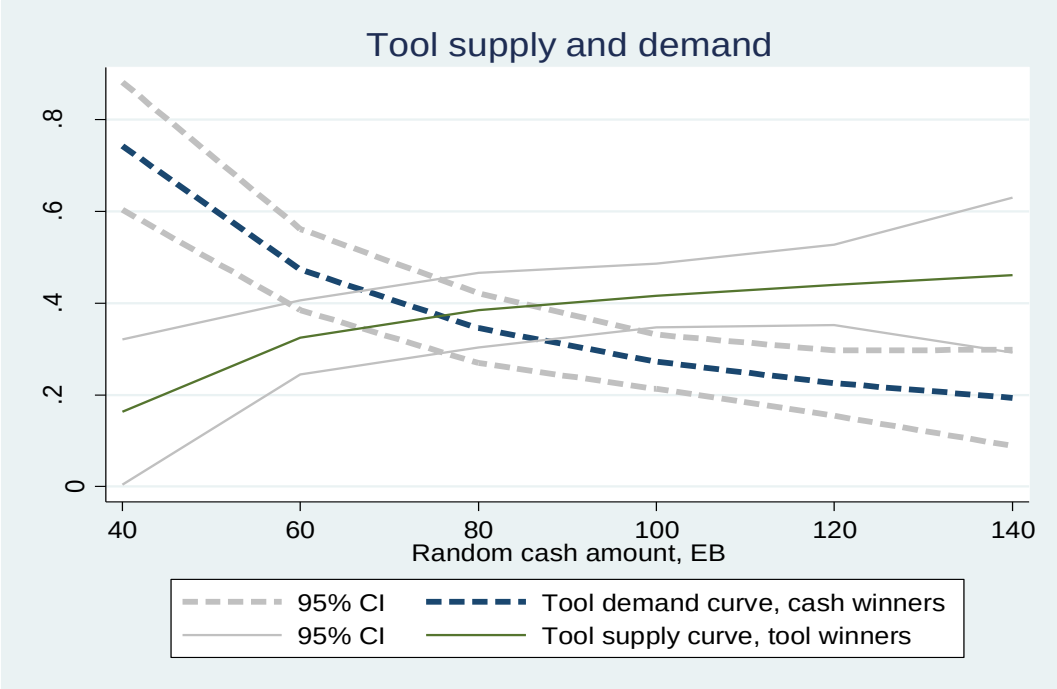


Figure 1. Supply and demand probabilities for tool, all respondents

Figure 2 shows the demand and supply curves for a small bag of fertilizer with a market price of 100EB at the time of the experiments. We found a surprising low demand for fertilizer. Approximately 40% of the cash receivers were willing to buy fertilizer at a price of 40EB, whereas approximately 25% of the fertilizer receivers were willing to sell the fertilizer at this low price. It is evident from Figure 2 that supply elasticity is higher than demand elasticity at low prices. More than 60% of the fertilizer receivers were willing to sell the fertilizer at 60 EB, that is, at a 40% discount from the current market price. Additionally, approximately 75% were willing to sell the fertilizer at 80 EB. At fertilizer prices above 100 EB, the supply and demand elasticities are low. A certain small fraction of the population highly values fertilizer.

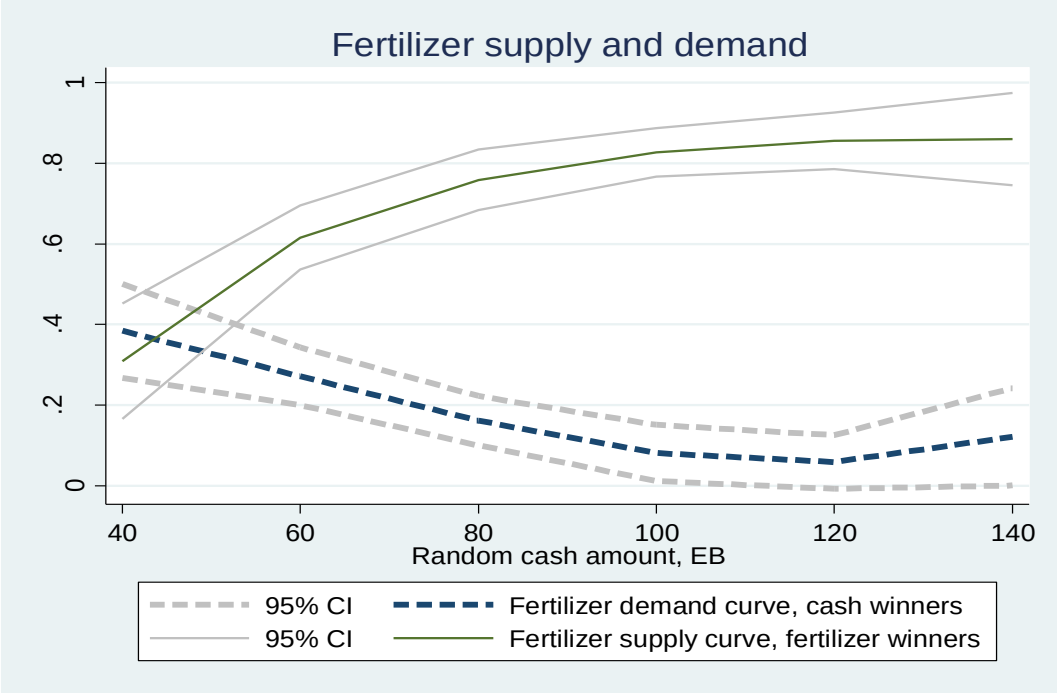


Figure 2. Supply and demand probabilities for fertilizer, all respondents

We also disaggregate the input demand and supply curves by gender, as the disaggregated parametric analyses revealed significant gender differences. Figures 3 and 4 show supply and demand for the tool for the men and women. The much stronger non-linear price response for the men than for the women is the most important difference. Similarly, Figures 5 and 6 show the demand and supply curves for fertilizer for the men and women, respectively. Again, we see many

more non-linear responses for the men, particularly on the supply side. The women are less likely to buy fertilizer even at the lowest price of 40 EB, whereas the men show higher supply elasticity in the range from 40 to 80 EB.

Overall, the study has revealed a low demand for fertilizer and that provision of subsidized fertilizer is not likely to be an effective method of stimulating agricultural production in the study areas. The fairly low shadow prices for fertilizer that the study revealed stand in contrast to the high shadow prices for fertilizer that Holden and Lunduka (2014) found in Malawi, which revealed that the tools distributed in the study were very popular and less likely to be resold if given to the respondents. On the other hand, our study shows high demand for tools. Such tools have largely been neglected in agricultural extension programs, whereas fertilizer and improved seeds usually receive a great deal of attention. The findings may indicate that a wider perspective on productive investment may be worthwhile.

Our assessment of exchange asymmetries revealed that such asymmetries remained high after we removed the basic transaction costs that characterize most agricultural factor markets in rural areas in developing countries. The inelastic demand and supply responses, particularly at higher prices, show that non-price factors are important. Loss aversion contributed significantly to exchange asymmetries for the durable productive asset and may indicate that endowment-effect theory plays a role. We found no significant effect of education or farming experience other than that explainable by the significant gender difference. Inclusion of preference ranks also improved the explanatory power of our models but did not eliminate exchange asymmetries; however, they at least partly captured differences in loss aversion. There must be some remaining psychological transaction costs that we were unable to eliminate but that can explain the remaining exchange asymmetries. This could possibly be explained by fatalistic thinking ("acceptance of God's will") related to lottery outcomes. However, further investigation is needed to dig deeper into causes of substantial unexplained exchange asymmetries.

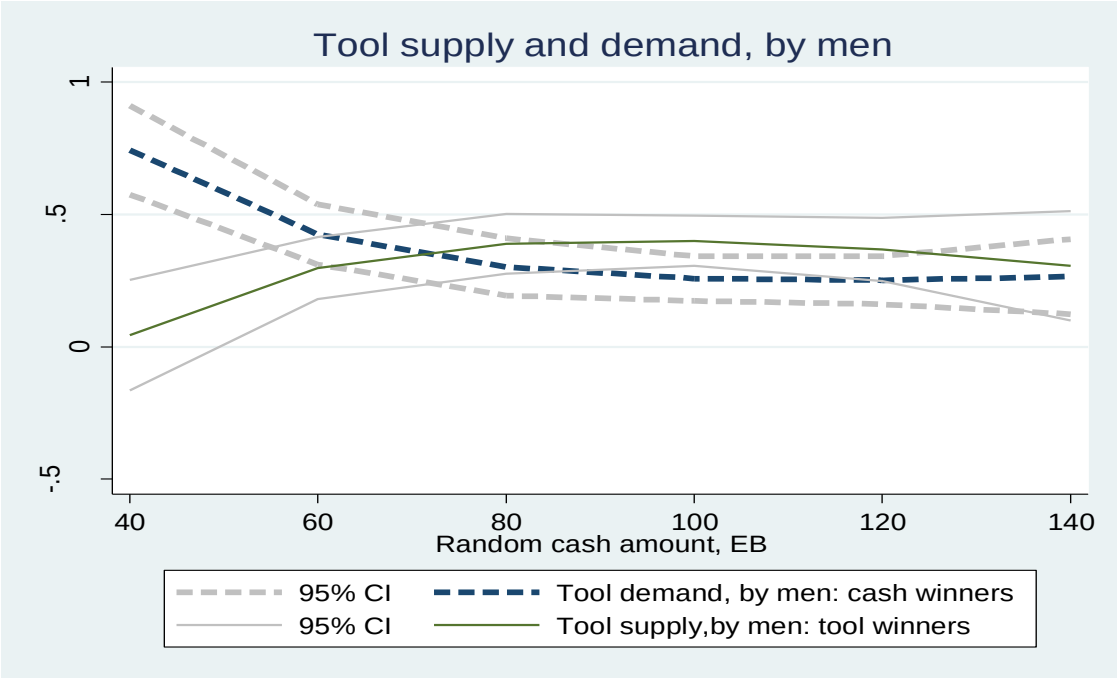
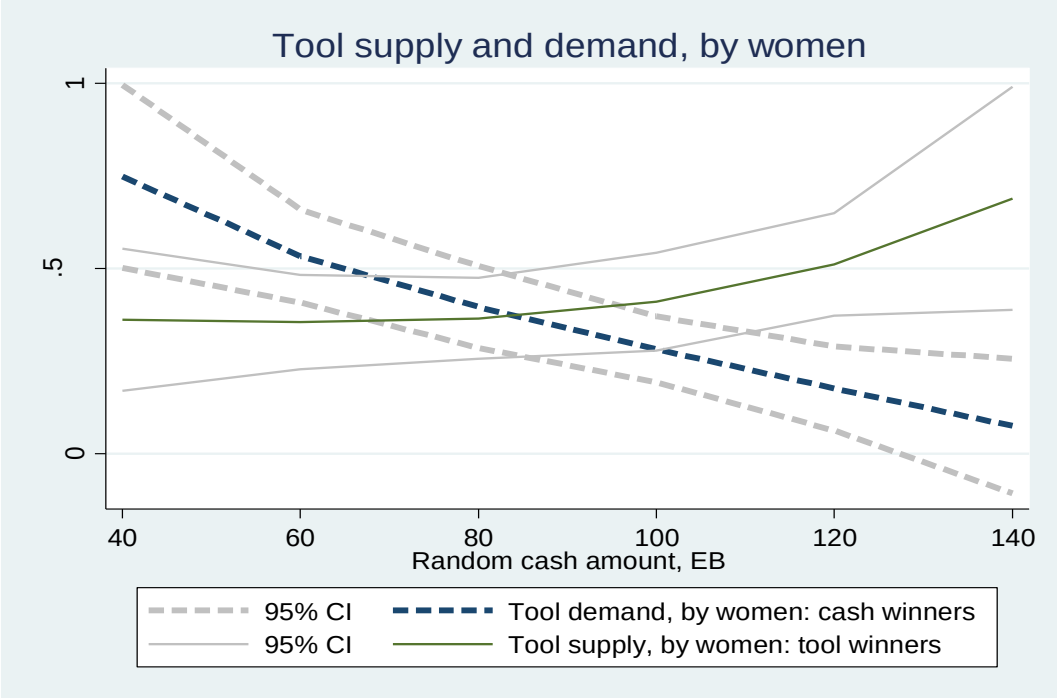


Figure 3. Tool supply and demand, men



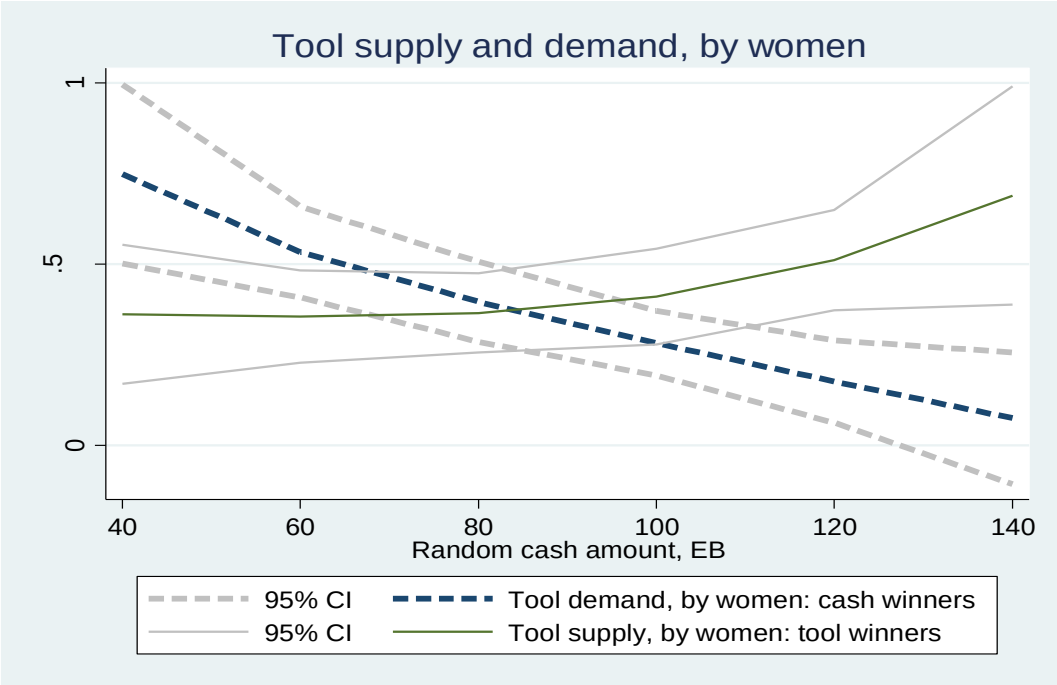


Figure 4. Tool supply and demand, women

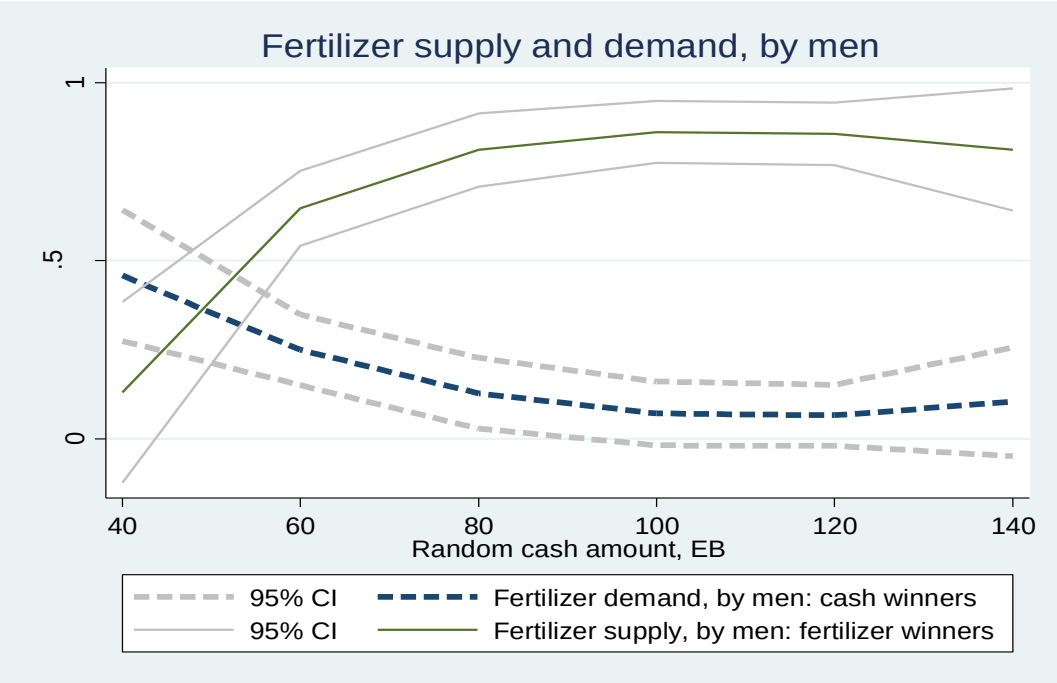


Figure 5. Fertilizer supply and demand, men

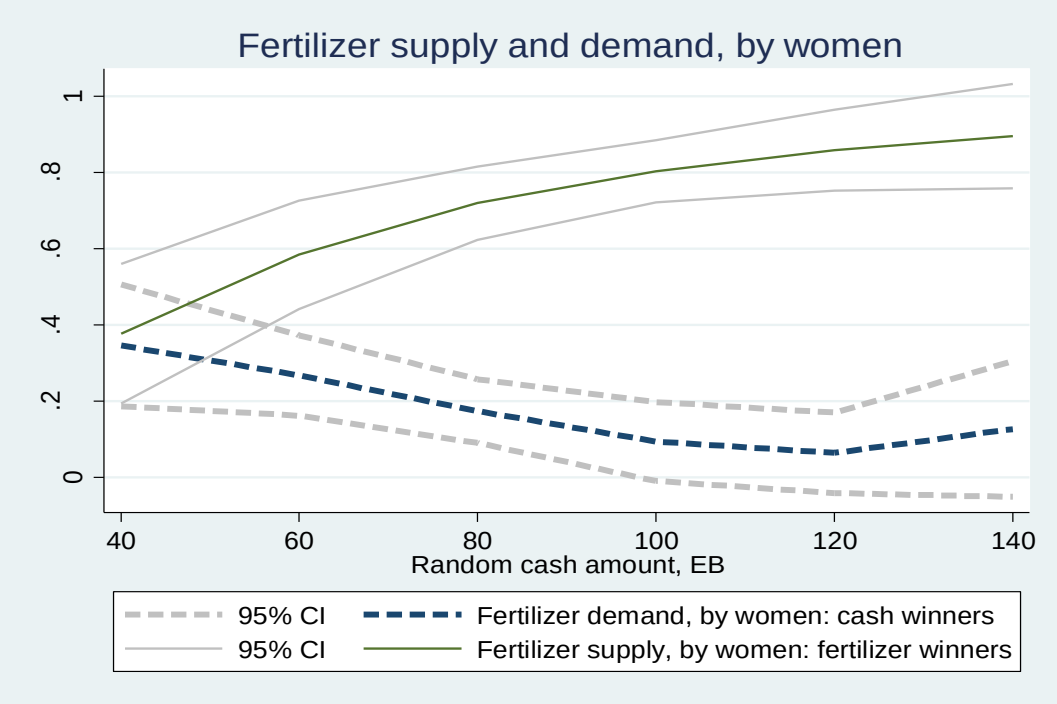


Figure 6. Fertilizer supply and demand, women

7. Conclusion

In this paper, we investigated the existence of exchange asymmetries in two types of productive assets among poor rural men and women in Ethiopia with a field experiment that eliminates standard high transaction costs and information asymmetries that are so dominant in these environments. The study therefore reveals whether there are additional behavioral and preference-related constraints to the adoption of these technologies and whether loss aversion lends support to endowment effects theory as an explanation of exchange asymmetries after removal of physical barriers. Substantial exchange asymmetries were found, especially for the more popular tool. Loss aversion was found to play a significant but small role in explaining observed exchange asymmetries. The experience of the respondents did not reduce the exchange asymmetries; rather the opposite was found as the men revealed greater exchange asymmetries than did the women; however, the men have more experience with trade and use of the productive assets under consideration in this study. We also found no difference between probabilistic ownership and certain ownership. A random allocation process was used to eliminate the danger of experimental

enumerators imposing value judgments that could otherwise have influenced the respondents. Controlling for the preference ranking of commodities and cash did not eliminate the exchange asymmetries. Our study contributes to the limited research on exchange asymmetries in a development context by investigating the relevance of behavioral economics theories to the analysis of the behavior of poor people.

The findings have relevance for rural development policies. Substantial exchange asymmetries exist after removing hard constraints and may point in the direction of commodity transfers as a method of enhancing technology adoption but only if the technology is in high demand. Perhaps surprisingly, our study revealed a high demand for agricultural tools, whereas fertilizer was less popular. The preference ranking showed that cash was in high demand and was as popular as receiving the tool, whereas fertilizer was substantially less popular even though the experiments were implemented close to the beginning of the rainy season. This contrasts with the study by Holden and Lunduka (2014) in Malawi, where a very high demand for small bags of fertilizer was revealed in experiments of a similar type. This illustrates that caution should be exercised when generalizing findings. Our study covered diverse agro-ecological conditions in Ethiopia and may therefore be of development relevance in other parts of the country. Our study revealed significant gender differences in exchange asymmetries and response elasticities, with the men revealing higher exchange asymmetries and more-non-linear price response elasticities. More studies are needed to assess the robustness of these gender-related findings.

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Appendix. Field experiment instrument

1. Commodity preferences:

Choice between 1= Hoe/plough/fork, 2=6 kg basal fertilizer (DAP), 3=100 Birr

Choices are made separately by husband and wife without them knowing what the other one chooses.

Husband's choice (Player 1): Rank 1:_____Rank 2:_____Rank 3:_____

Wife's choice (Player 2): Rank 1:_____Rank 2:_____Rank 3:_____

2. Endowment effect game: Separate for husband and wife

The players should play separately without the other one seeing or being able to influence the choice. One of the plays will be real. A coin will be used afterwards to identify which of the players' outcomes/choices will be the real one. They will then be asked to share this outcome.

Player 1 (Head of household):_____

Coin toss 1: Identify whether **Head=Tool** or **Tail=Fertilizer** will be the commodity.

Outcome (circle): 1=Tool, 2=Fertilizer:_____

Coin toss 2: Identify whether the player receives the commodity or a random amount of cash.

Outcome (circle): 1=Head=Commodity, 2=Tail=Random cash amount

The predetermined (by throwing a die) random amount of cash level **(circle): 40, 60, 80, 100, 120,140 EB**.

If the player received the commodity, s/he is offered to sell it back for the random amount of cash. If the player received cash, s/he can use the money to buy the commodity.

Choice (circle): 1=Keep, 2=Exchange

Player 1 (Husband) is asked to leave the room and come back after the wife has played to identify by a coin toss what the final outcome will be. The wife is asked to come in without communicating with the husband or knowing the outcome for him **(Important!).**

Player 2: (not for household heads without spouse)_____

Coin toss 1: Identify whether **Head=Tool** or **Tail=Fertilizer** will be the commodity.

Outcome (circle): 1=Tool, 2=Fertilizer:_____

Coin toss 2: Identify whether the player receives the commodity or a random amount of cash.

Outcome (circle): 1=Head=Commodity, 2=Tail=Random amount of cash

The predetermined random amount of cash level **(circle): 40, 60, 80, 100, 120,140 EB**.

If the player received the commodity, s/he is offered to sell it back for the random amount of cash. If the player received cash, s/he can use the money to buy the commodity

Choice (circle): 1=Keep, 2=Exchange

The husband is asked to come in as well. The final coin toss will determine which of the two players' game will be the real one. For household heads that do not have a spouse the game is real (no player 2). For polygamous households play with random available wife.

Final coin toss (circle): 1=Head=Player 1, 2=Tail=Player 2

Outcome: 1=Tool, 2=Fertilizer, 3=Cash amount:_____

The household receives the preferred choice of the winning player and are asked to share it.

3. Loss Aversion (money)

- Play this game with the head of household.
- The household head is first given 20 EB that s/he will have to risk all or some of in the following game.
- **Instructions to players**: You have a choice between participating in two lotteries. Each of them has a 50% chance of winning, and 50% chance of losing (by tossing a coin). First choice: "Lottery A will give you 25EB extra if the coin toss lands on Head, and you have to give back 5EB if it lands on Tail. Lottery B will give you 30 EB extra if coin lands on Head but you will lose all the 20 EB if it lands on Tail. Do you choose Lottery A or Lottery B?
- **Instructions to instructors**: Introduce each of the seven lottery choices in a similar way as above to determine the switch point from Lottery A to Lottery B. Tick the preferred lottery (A or B) in each row. Only one of these seven games will be randomly sampled and played for real (by selecting one card out of seven numbered from 1 to 7. There should typically be one switch point where they switch from Lottery A to Lottery B (consistent behavior) but always choosing one of the lotteries would also be consistent.

No	Lottery A	Choice	Lottery B	Choice
1	50% of winning 25 EB and 50% of losing 5 EB		50% of winning 30 EB and 50% of losing 20 EB	
2	50% of winning 5 EB and 50% of losing 5 EB		50% of winning 30 EB and 50% of losing 20 EB	
3	50% of winning 1 EB and 50% of losing 5 EB		50% of winning 30 EB and 50% of losing 20 EB	
4	50% of winning 1 EB and 50% of losing 5 EB		50% of winning 30 EB and 50% of losing 16 EB	
5	50% of winning 1 EB and 50% of losing 8 EB		50% of winning 30 EB and 50% of losing 16 EB	
6	50% of winning 1 EB and 50% of losing 8 EB		50% of winning 30 EB and 50% of losing 14 EB	
7	50% of winning 1 EB and 50% of losing 8 EB		50% of winning 30 EB and 50% of losing 11 EB	

Mark the play that was sampled to be real: **Game no**:_____
Outcome of the game: Amount lost:_____ Amount won:_____
Table A1. Preference ranking for tool, fertilizer and cash for male and female respondents

Appendix 2.

Table A2.1. Preference ranking for tool, fertilizer and cash for male and female respondents

Male pref. rank 1	Freq	Percent	Cum.	Female pref. rank 1	Freq.	Percent	Cum.
Tool	273	47.64	47.64		177	35.12	35.12
Fertilizer	35	6.11	53.75		48	9.52	44.64
Cash 100 EB	265	46.25	100.00		279	55.36	100.00
Total	573	100.00		Total	504	100.00	
Male pref. rank 2	Freq.	Percent	Cum.	Female pref. rank 2	Freq.	Percent	Cum.
Tool	227	39.69	39.69		240	47.62	47.62
Fertilizer	168	29.37	69.06		138	27.38	75.00
Cash 100 EB	177	30.94	100.00		126	25.00	100.00
Total	572	100.00		Total	504	100.00	
Male pref. rank 3	Freq.	Percent	Cum.	Female pref. rank 3	Freq.	Percent	Cum.
Tool	74	12.94	12.94		86	17.06	17.06
Fertilizer	367	64.16	77.10		317	62.90	79.96
Cash 100 EB	131	22.90	100.00		101	20.04	100.00
Total	572	100.00		Total	504	100.00	

Table A2.2. Commodity preference ranks and correlates

	Tool preference rank	Fertilizer preference rank	Cash preference rank
Loss aversion rank	-0.031**	-0.000	0.032**
	(0.01)	(0.01)	(0.01)
Sex of respondent, dummy: 1=male	-0.182****	0.043	0.139***
	(0.03)	(0.04)	(0.05)
Female headed, dummy	-0.069	0.032	0.037
	(0.09)	(0.06)	(0.10)
Age of household head	0.003	0.000	-0.003
	(0.00)	(0.00)	(0.00)
Education of household head	0.001	-0.004	0.004
	(0.01)	(0.01)	(0.01)
Farm experience of head, years	0.002	-0.001	-0.001
	(0.00)	(0.00)	(0.00)
Constant	1.726****	2.575****	1.699****
	(0.12)	(0.14)	(0.16)
Prob > chi2	0.000	0.879	0.011
R-squared	0.038	0.002	0.024
Number of observations	959	959	959

Note: OLS models with cluster-robust standard errors with clustering at village level. Standard errors in parentheses. Significance levels: *: 10%, **: 5%, ***: 1%, ****: 0.01%. The dependent variables take three outcomes; rank variable=1 for most preferred, =2 if second most preferred, and =3 if least preferred.

Figure A1. Example of tools used in the experiments.