AJAE Online Appendix to: “Buyers’ response to third-party quality certification: Theory and evidence from Ethiopian wheat traders”

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Note: The material contained herein is supplementary to the article named in the title and published in the American Journal of Agricultural Economics.

Experiment: protocol

Script

We presented the following script to traders in their native language (Amharic or Afan Oromo) after the survey.

Enumerator: *please inform the trader that he/she will now play (marketing) games that involve buying and selling bags of 10kg of wheat (chips). Please also inform the trader that he/she will play the game as a wheat trader, and you (the enumerator) will represent the miller. Now, clearly explain the below "rules of the game".*

Jars and chips. Let's consider that you are on a market, and farmers supply wheat of different quality. As usual, you are buying wheat and selling it to millers. Farmers can certify their wheat before selling it on the market and signal it using a specific bag. Hence, you know the quality of the certified wheat with **certainty**. However, some farmers don't certify their wheat, use their bag, and you cannot distinguish between low and high-quality wheat. According to the market, the average quality supply can be highly variable. We have some jars here with chips that represent 10 kg of wheat. These jars contain blue and red chips. The blue chips correspond to high quality-certified wheat, while the red chips are uncertified wheat. Thus, the red chips (the uncertified wheat) can be either low- or high-quality wheat. The proportion of blue and red chips within each jar is varying. Let's draw a few chips so that we can see.

Enumerator: *please show chips in front of each jar and show the trader that all the jars will have blue and red chips (with and without dot) but different proportions. Then, fill the jar with the appropriate chips.*

Sessions and rounds. When traders visit markets, they use trucks and aim to fill them to recover their fixed costs. However, according to the market size they may have a leeway to select wheat among what farmers supply. You will play 8 games corresponding to different market settings. Each game will lead to a potential earning, and you will be paid from one at the end. You will draw some chips from the jar to select and buy **exactly 12 chips** – as if you wanted to fill up your truck, you will later sell to the experimenter (who represents a miller). Remember that you must select and buy 12 chips, which you

will later sell to the experimenter (miller). You will draw the chips one by one, and each time you decide whether you want to buy the chip, you draw or reject it (***Enumerator:*** *you MUST record the choice made by the trader*).

Buying chips and its prices. As indicated before, the blue chips represent high-quality certified wheat, and the red chips represent uncertified wheat. Thus, the buying price for blue chips is always higher than red ones. **A blue chip costs 220 birr** to buy, and a **red chip costs 200 birr**. At that time, you do not know whether the red chip represents a high or low-quality wheat.

Selling chips to a miller and its prices. After buying wheat on the market, traders usually sell it to millers, and the price varies according to the average quality bought. Millers pay a premium for high-quality certified wheat and rely on certification grade because it provides all information about unobservable quality. Certified wheat is valued only if it is kept separate from uncertified wheat. However, traders must make up-front investments in capital such as trucks or storage facilities to keep certified wheat separated.

As indicated before, you will have the opportunity to sell the chips directly to a miller (represented by me, the experimenter). Before beginning each game, you must decide whether you want to sell blue chips (high-quality certified wheat) separately. If you choose to sell the blue chips separately, you **MUST** buy a specific **cup to store blue chips at 330 birr before drawing any chips. In that case, you will be sure to obtain 280 birr per blue chip** when you sell it to the miller. For the red chips, the miller will assess the average quality of these chips and pay you accordingly (on average **220 birr per chip if you have only low-quality chips, 240 birr if you have only high-quality chips and something in between for intermediate cases**). A red chip is high-quality wheat if a mark is drawn under the opaque adhesive tape.

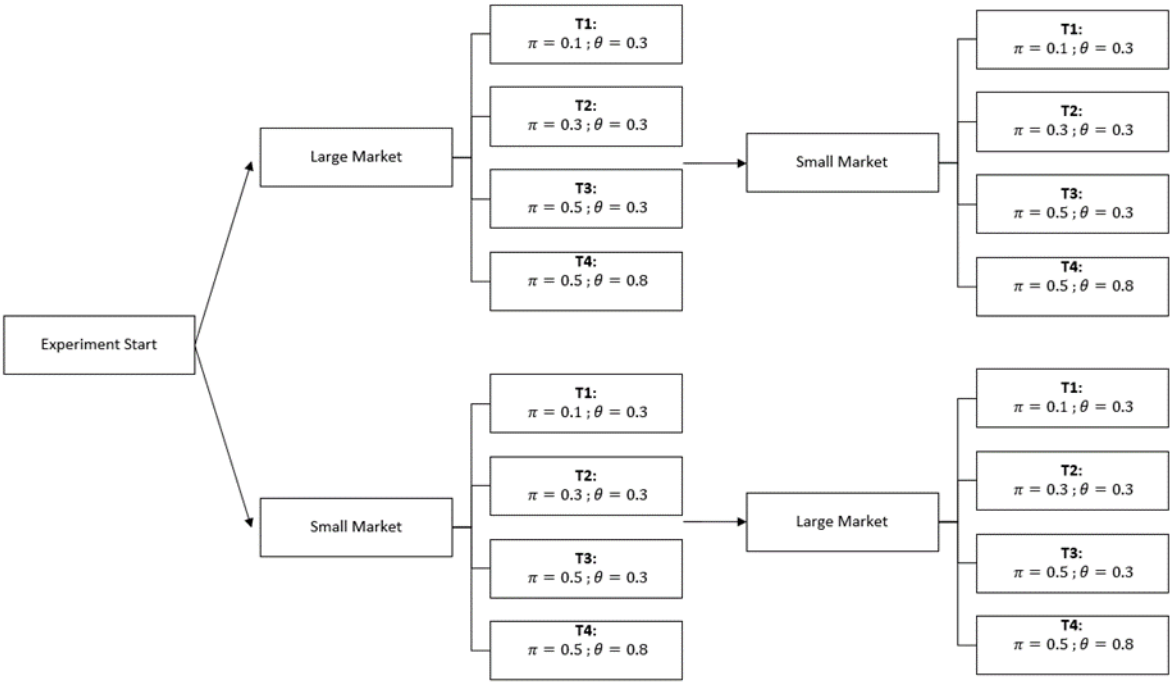
If you decide not to sell the blue chips separately, you can mix them with the red chips and sell them to the miller. In that case, the blue chips have the same value as the high-quality red chips. The miller will assess the average quality of the mixed chips and pay you accordingly (on average **220 birr per chip if you have only low-quality chips, 240 birr if you have only high-quality chips, and something in between for intermediate cases**).

Return (profit). At the end of each game, I will assess the average quality of your wheat and determine your potential earnings. After you play the eight games, we will randomly select one of the games using the tablet, and you will be paid the amount you earned in the corresponding game.

Enumerator: *Ask the trader the following questions to make sure that he/she understand the game.*

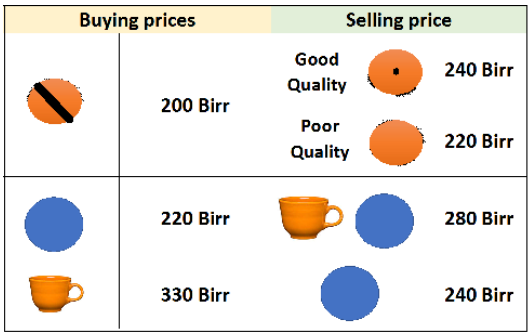
Support documents

Figure B.1. Experimental design diagram

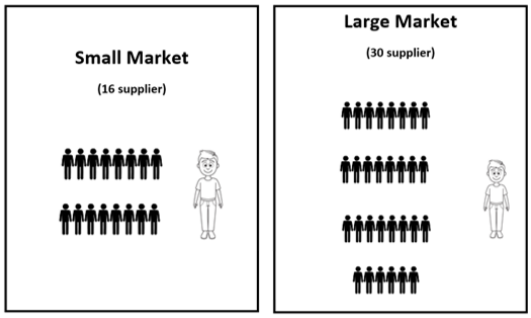


Notes. This figure shows the experimental design. We randomly assign the order in which 178 traders will play the large market or small market session. Then, within each session we also randomly assign the order in which a trader play the four treatment variations (i.e., T1, T2, T3, T4). Small (large) market session is session where traders could draw 16 (30) chips. π is the share of certified wheat and can take three values (10%, 30%, and 50%). θ is the share of uncertified wheat of high-quality and can take two values (30% and 80%).

Figure B.2. Summary sheets



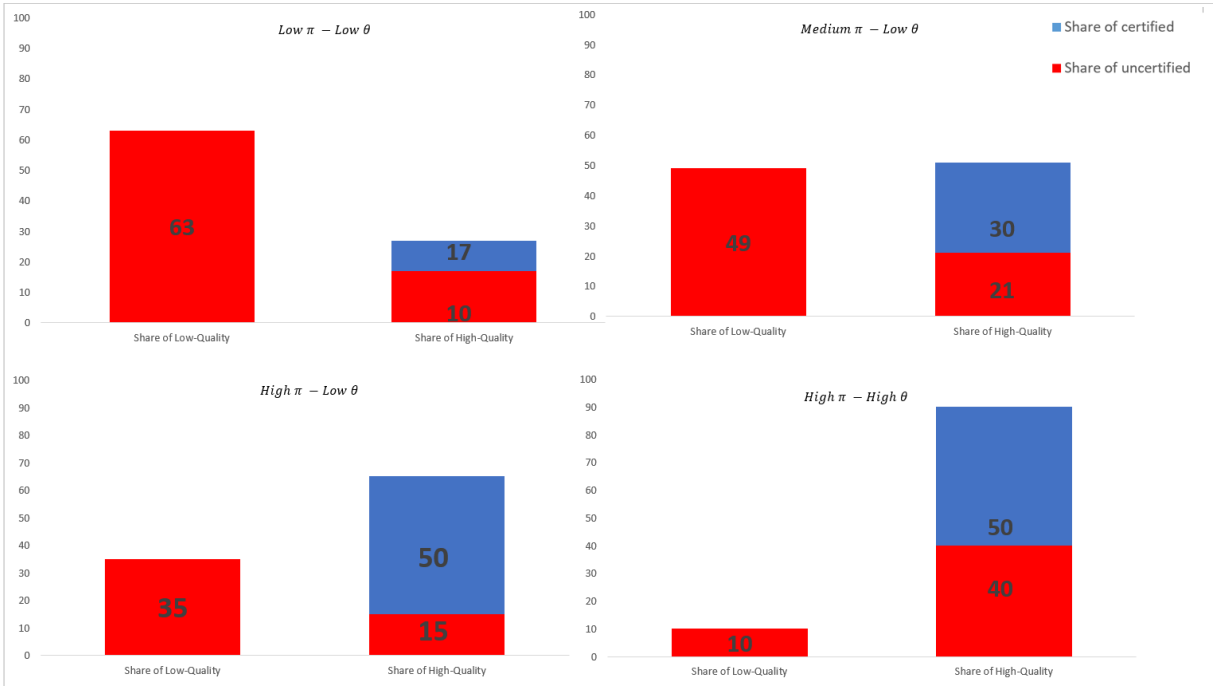
A. Rules of the game



B. Market Size

Notes. This figure shows the summary sheets provided to the traders. The sheets summarize the rules of the game and different settings in which traders have to take their decisions.

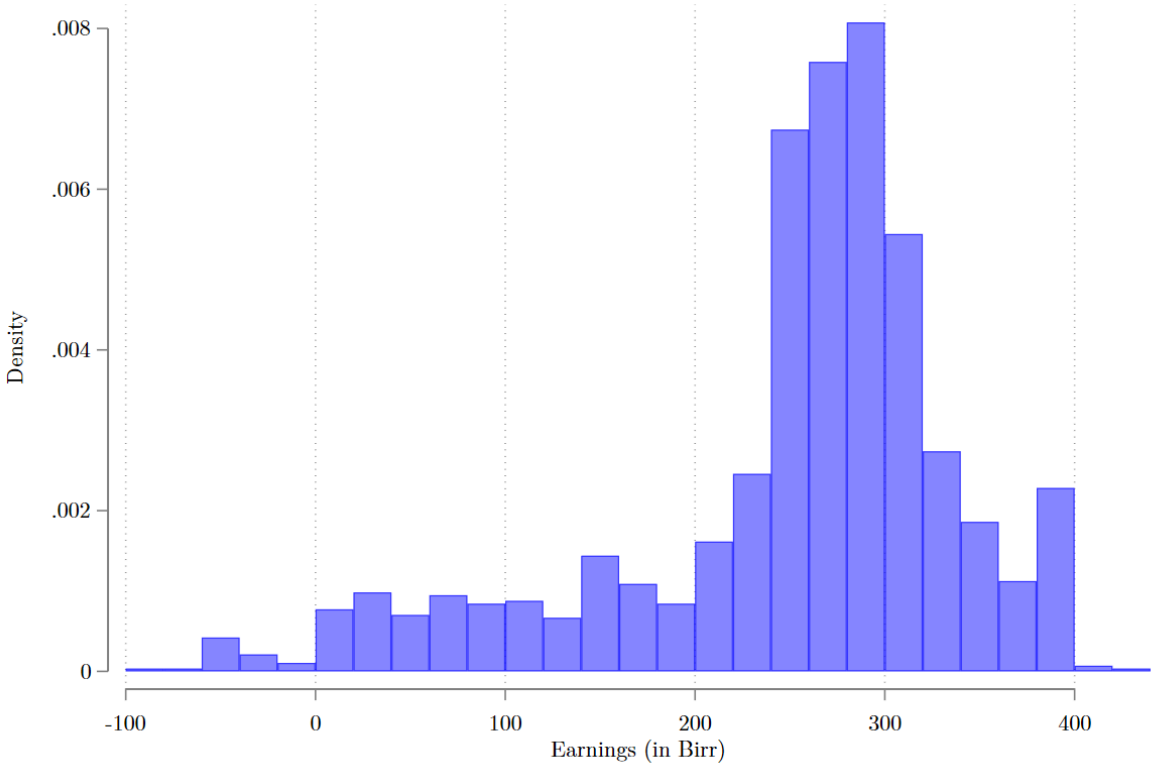
Figure B.3. Treatment game support materials



Notes. This figure shows the support materials provided to the traders. It shows the different cases under which traders have to take their decisions.

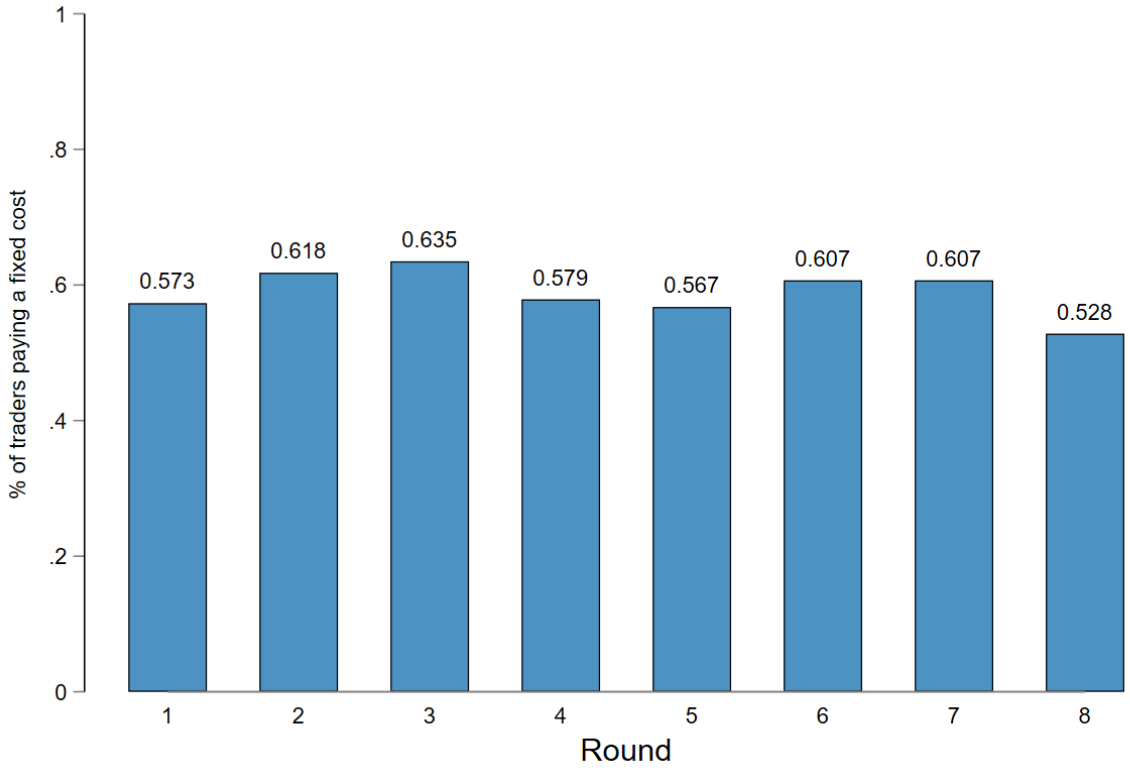
Additional results

Figure C.1. Traders' profits



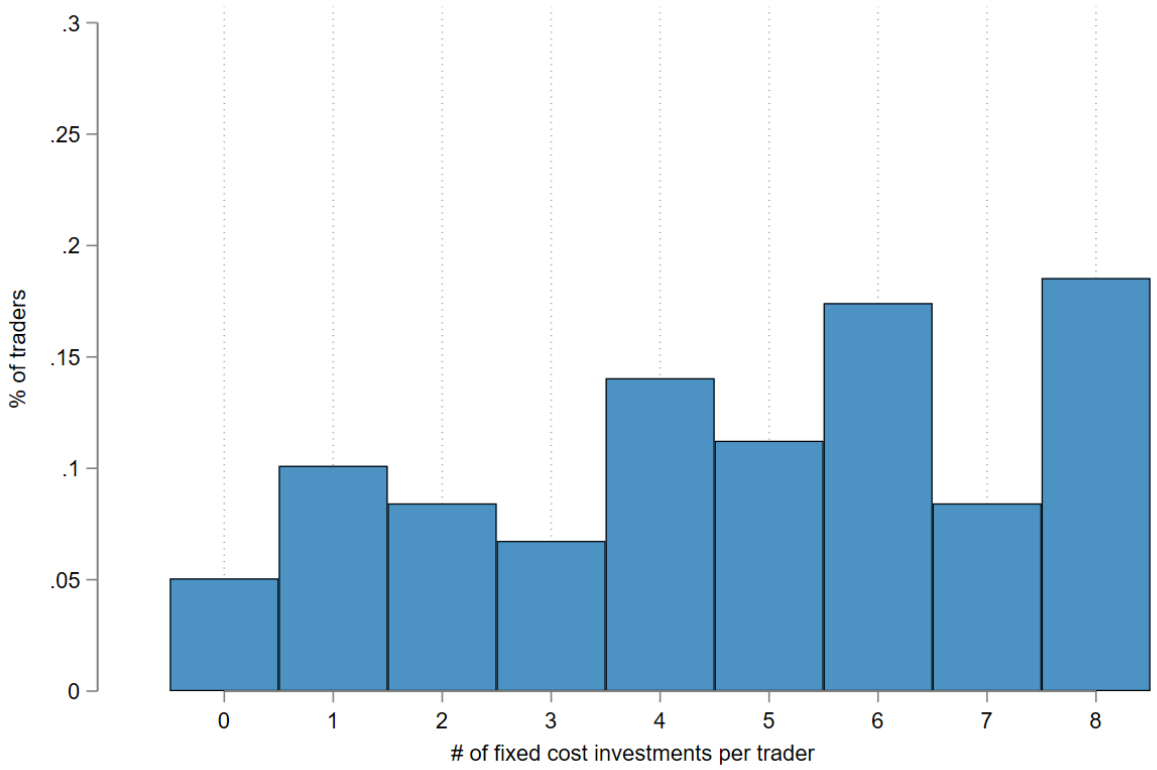
Notes. This figure shows the distribution of traders' profit across all games. The profits are expressed in Birr.

Figure C.2. Proportion of traders incurring a fixed cost, by round



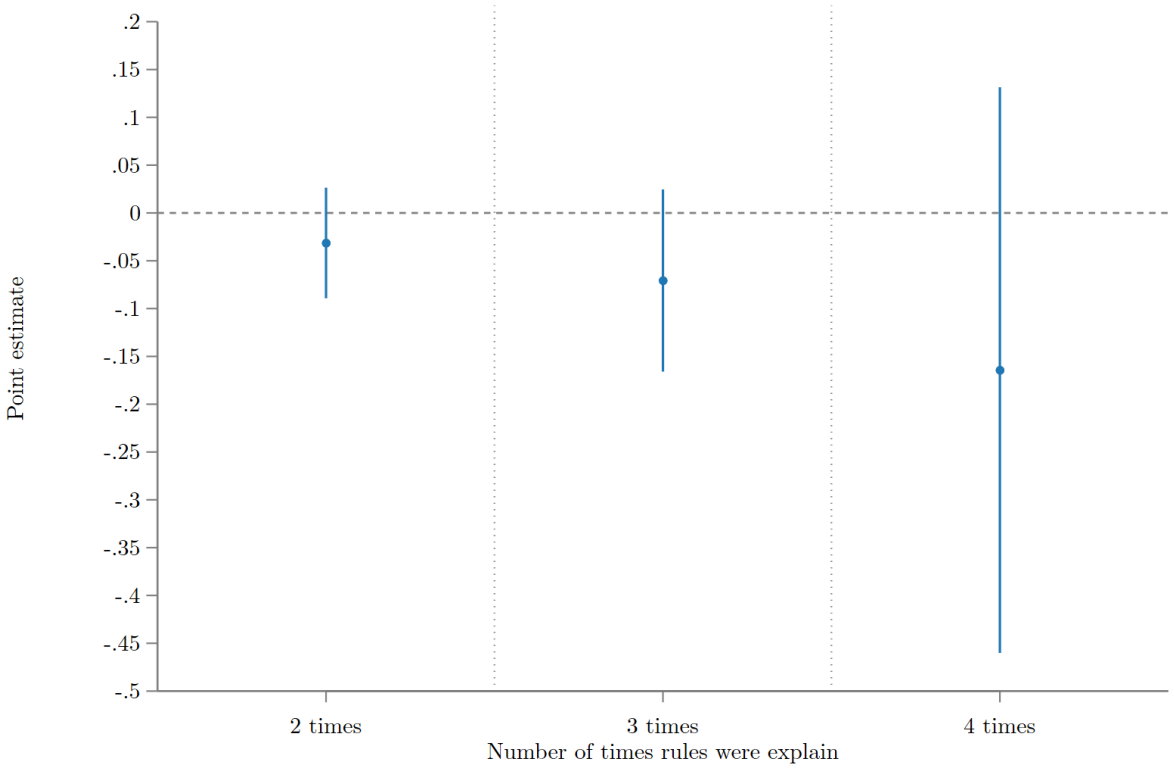
Notes. This figure shows the proportion of traders incurring a fixed cost across the different game round.

Figure C.3. Number of fixed-cost investments per trader during the game



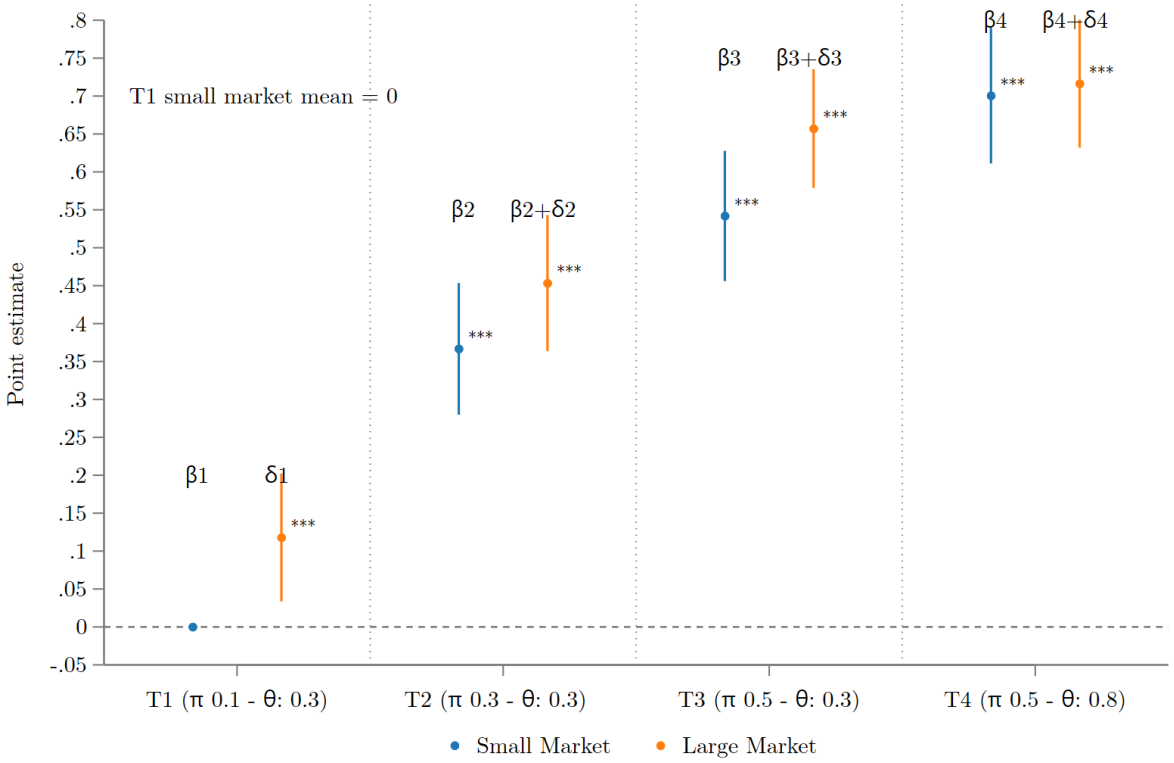
Notes. This figure shows the distribution of the total number of fixed-cost investments traders incurred across all games.

Figure C.4. Traders investment decisions across market conditions and market sizes



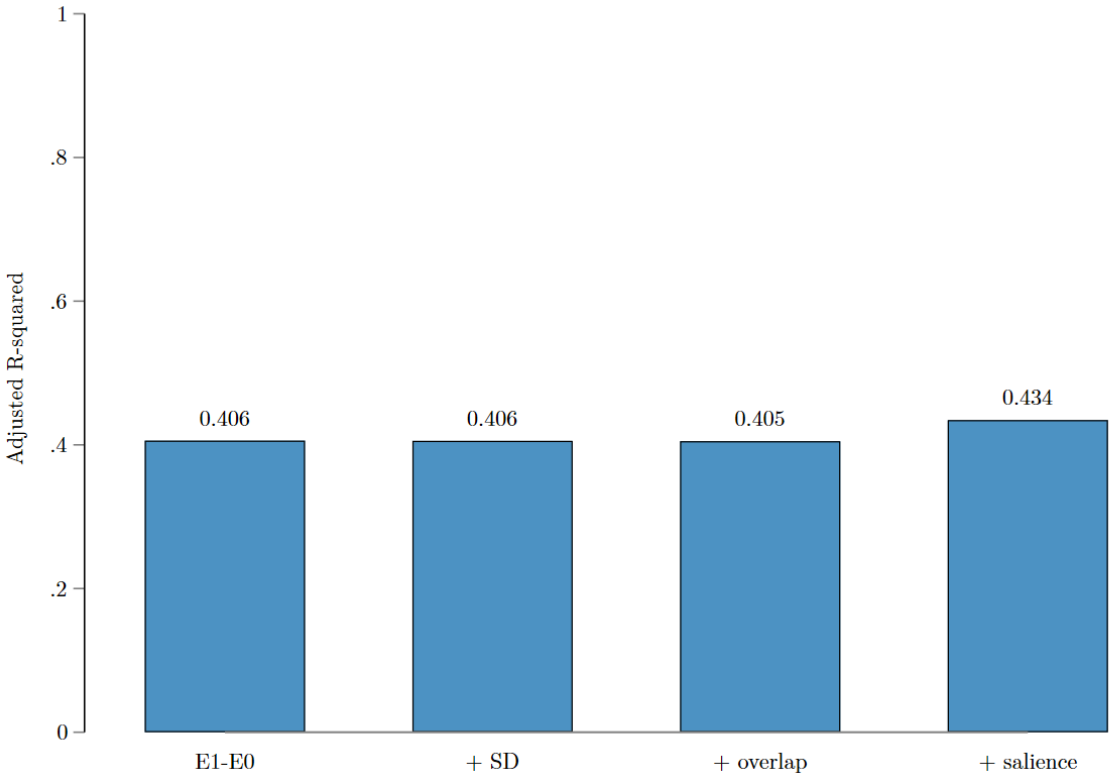
Notes. This figure shows the relationship between the probability to make an optimal decision regarding the fixed cost investment and participants' comprehension of the games. Comprehension of the participants is the number of times the enumerator had to explain the rules of the game and ranges from 1 to 4 times. 95% confidence intervals are based on robust standard errors. Controls include age, sex, number of years as wheat traders, number of years of education, and game order and trader fixed effects. *** p<0.01, ** p<0.05, * p<0.1. Unit of observation is participant × game level.

Figure C.5. Traders investment decisions across market conditions and market sizes - restricted sample



Notes. This figure shows the probability of paying the fixed cost in a given game, relative to the probability of paying it in the T1 small market game. Each dot corresponds to the estimated coefficient associated with a given a treatment arm (specific combination of π and θ), along with its interaction with market size, as per equation **??**. π is the share of certified wheat. θ is the share of high-quality wheat among uncertified wheat. Coefficient estimates are in blue for small market games and orange for large market games. T1 small market is the omitted category (β_1). Sample is restricted to traders making the optimal decision in Treatment 1. 95% confidence intervals are based on robust standard errors. Controls include game order and trader fixed effects. *** p<0.01, ** p<0.05, * p<0.1. Unit of observation is participant × game level.

Figure C.6. Sources of variation explained in fixed cost decisions



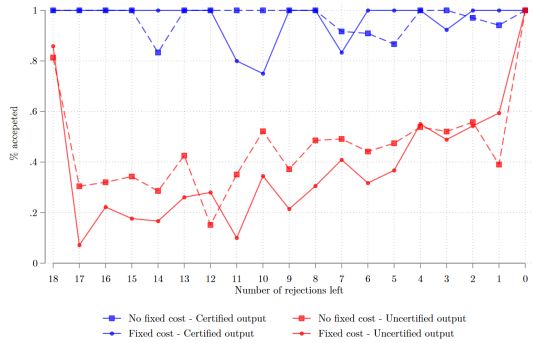
Notes. This figure shows the fixed cost decision variation sources. It reports the share of total fixed cost decision dispersion explained when estimated using a series of decision function specifications, including additional controls beyond expected utility. Bar on the far left was estimated from a model including only expected earnings returns to paying the fixed cost. Left-to-right, subsequent specifications add (i) the standard deviation of the earning difference after paying or not the fixed cost, (ii) the overlap in earnings distribution with and without paying the fixed cost, and (iii) the tangent function of the expected returns to paying the fixed cost.

Table C.1. Treatment effects on trader decisions to pay a fixed cost

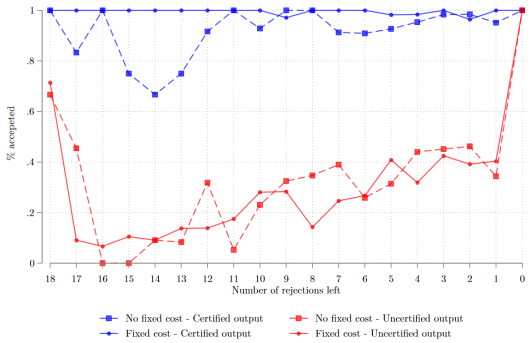
	Small Market	Large Market	Full Sample
	(1)	(2)	(3)
T2	0.19***	0.25***	0.20***
	(0.04)	(0.04)	(0.04)
T3	0.30***	0.42***	0.30***
	(0.04)	(0.04)	(0.04)
T4	0.42***	0.44***	0.43***
	(0.04)	(0.04)	(0.04)
T1 × Large Market			-0.01
			(0.04)
T2 × Large Market			0.05
			(0.06)
T3 × Large Market			0.11**
			(0.05)
T4 × Large Market			0.00
			(0.06)
T2=T3 *p*-value	.00	.00	.00
T3=T4 *p*-value	.00	.62	.00
T3 + T3 × Large Market = T4 + T4 × Large Market *p*-value			.66
Trader FE	Yes	Yes	Yes
Order FE	Yes	Yes	Yes
N	712	712	1424
Outcome mean, T1	.34	.33	.33

Notes. Dependent variable is a dummy equals 1 if the trader incurs a fixed cost before the game. π is the share of certified-wheat. θ is the share of uncertified high-quality wheat. Small market corresponds to small market game (16 draws) Large market corresponds to large market game (30 draws). Results are based on small market games in column 1, large market games in column 2, and full sample in column 3. The value of reference is the low share of certified wheat case ($\pi = 0.1$). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

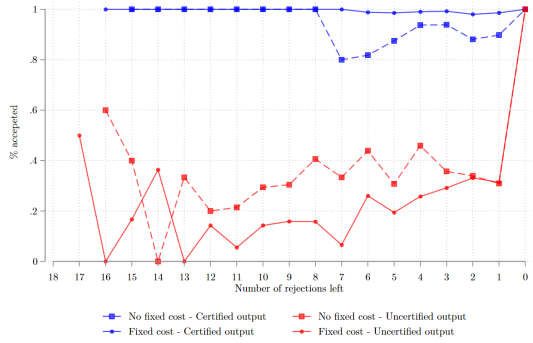
Figure C.7. Acceptance rate per round in large market



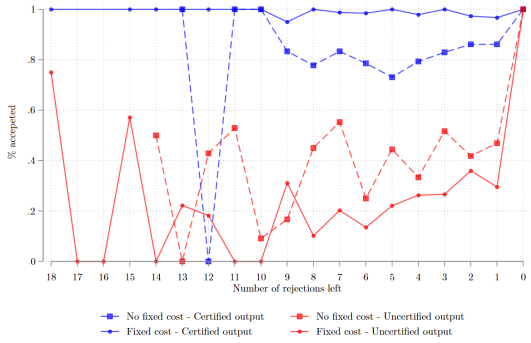
A. Low π - Low θ



B. Medium π - Low θ



C. High π - Low θ



D. High π - High θ

Notes. This figure shows for each treatment the proportion of chips drawn accepted at a given round before and after the Farmer N (M) threshold if they (do not) pay the fixed cost. Farmer N (M) is the farmer after which the number of remaining encounters with farmers on that day is equal to the number of remaining empty slots on the rented truck. Farmer N (M) is not displayed when its value is larger than the maximum number of rounds. Red lines represent the proportion of uncertified wheat output accepted at a given round. Blue lines represent the proportion of certified wheat accepted at a given round. Plain lines represent cases for which the trader incurs a fixed cost. Dashed lines represent cases for which the trader does not incur a fixed cost. π is the share of certified-wheat. θ is the share of uncertified high-quality wheat.

Monte Carlo analysis

Relying on our theoretical model outlined in Section **??**, we employ a Monte Carlo approach to estimate the first and second-moment conditions of earning distribution for each market case (8 in total) conditional on the initial decision to incur the fixed cost. The objective is to estimate the coefficient variation of earnings for each game, which captures the riskiness of a market case to some extent.

Following each case mentioned in Section **??**, we define earnings functions after incurring or not the fixed cost according to the model's parameters: market size, the share of uncertified high-quality wheat (θ), and the share of certified wheat (π). This replicates the earnings functions derived from our theoretical model to each game traders face in real life. In other words, we have two earnings functions per game: one after incurring the fixed cost and one without incurring it.

In each game, a trader's earnings function depends on her choice to incur the fixed cost or not. We generate 1,000 rounds played for each game. Each round involves up to 16 or 30 repeated draws, according to the market size, from the sample containing 36 certified and non certified wheat units without replacement. We assign a uniformly distributed random number to each chip over the interval [0,1] and rank them accordingly. After each draw, we apply the optimal decision rule to accept or not a given unit (see Section **??** and **??**) until 12 units are accepted. We compute the earning gap between the two fixed-cost cases for each simulation. Next, we calculate the average difference in earnings, the standard deviation of earnings difference over the 1,000 draws, and the overlap in earnings for each game. We measure overlap as the proportion of the earning distribution with and without the fixed cost which overlaps (similar to common support). Figure **??** shows the earnings distribution for small and large market cases. Table D.1 shows simulation results.

Table D.1. Simulated games characteristics

Market size	Small Market				Large Market			
Treatment Combinations	Low π Low θ	Medium π Low θ	High π Low θ	High π High θ	Low π Low θ	Medium π Low θ	High π Low θ	High π High θ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
E_1	-5.34	184.96	249.68	290.32	100.48	317.14	390.00	390.00
SD $[\mathbb{E}_1]$	14.02	14.57	13.30	13.09	19.23	16.47	0.00	0.00
E_0	288.72	285.12	269.98	330.92	280.50	274.02	264.46	338.24
SD $[\mathbb{E}_0]$	12.75	14.21	11.77	16.52	20.55	18.47	16.42	26.47
$\mathbb{E}[\mathrm{E}_1 - \mathrm{E}_0]$	-294.06	-100.16	-20.30	-40.60	-180.02	43.12	125.54	51.76
SD $[\mathrm{E}_1 - \mathrm{E}_0]$	8.05	12.37	12.07	17.11	13.33	21.62	16.42	26.47
Overlap	0.00	0.00	0.68	0.62	0.00	0.98	0.00	0.00
Salience	-0.84	0.95	2.24	2.35	-5.40	-1.83	0.86	-1.45

Notes. This table reports summary statistics results from 1,000 Monte Carlo simulations by game (treatment combination) and market size. Columns (1-4) show results for small market cases. Columns (5-8) show results for large market cases. E_1 measures average expected earnings (in Birr) after incurring the fixed cost. SD$[\mathbb{E}_1]$ is the earnings spread after paying the fixed cost. E_0 measures average expected earnings (in Birr) without incurring the fixed cost. SD$[E_1]$ is the earnings spread when not paying the fixed cost. $\mathbb{E}[E_1 - E_0]$ is the expected earnings difference between cases with and without paying the fixed cost. $SD[E_1 - E_0]$ is the spread of the earnings difference after paying or not the fixed cost. Overlap is the proportion of the earnings distribution in common between cases with and without paying the fixed cost. Salience is the tangent of the difference in expected earnings.

Data and Measures

This section provides further details on the construction of the behavioral variables used in the paper.

Present Bias Elicitation

We elicit intertemporal choices using the Convex Time Budget method (Andreoni et al., 2015). This approach allows us to measure to whether and to what extent individuals smooth time-dated monetary rewards. We can elicit all the parameter of the quasi-hyperbolic discounted model using only one experimental instrument: the discount factor δ, present bias β, and instantaneous utility function u. We asked traders to select a reward schedule from a set of 3 options delivered at two points in time given an inter-temporal budget constraint with a k-period gross interest rate, $1+r$. We are varying the time horizons and gross interest rate to identify the three parameters mentioned.

We asked traders to consider how much they would like to received for sure today and in 4 weeks from a set of 3 options over 5 reward schedules, then they do the same task over a different time horizon (4 weeks vs 8 weeks). Figure E.1 shows the survey materials used.

Figure E.1. Survey materials for time preferences elicitation

#	Question	Response options	CAPI notes
For each decision number below, decide the AMOUNTS you would like for sure **today** AND in **4 weeks** by checking the corresponding answer. *Example: In Decision 1, if you wanted 250 birr today and 0 birr in four weeks you would check the first answer.* *Remember to check only one answer per decision*			
D1a.	Would you like to receive X payment TODAY **and** Y payment in 4 weeks	1. 250 and 0 birr 2. 125 and 125 birr 3. 0 and 250 birr	Only 1 answer
D1b	Would you like to receive X payment TODAY **and** Y payment in 4 weeks	1. 225 and 0 birr 2. 113 and 125 birr 3. 0 and 250	Only 1 answer
D1c	Would you like to receive X payment TODAY **and** Y payment in 4 weeks	1. 200 and 0 birr 2. 100 and 125 birr 3. 0 and 250 birr	Only 1 answer
D1d	Would you like to receive X payment TODAY **and** Y payment in 4 weeks	1. 175 and 0 birr 2. 88 and 125 birr 3. 0 and 250 birr	Only 1 answer
D1e	Would you like to receive X payment TODAY **and** Y payment in 4 weeks	1. 150 and 0 birr 2. 75 and 125 birr 3. 0 and 250 birr	Only 1 answer

A. Task over short time period

For each decision number below, decide the AMOUNTS you would like for sure in **4 weeks** AND in **8 weeks** by checking the corresponding answer. *Example: In Decision 1, if you wanted 250 birr in four weeks and 0 birr in eight weeks you would check the first answer.* *Remember to check only one answer per decision*			
D2a.	Would you like to receive X payment in 4 weeks **and** Y payment in 8 weeks	1. 250 and 0 birr 2. 125 and 125 birr 3. 0 and 250 birr	Only 1 answer
D2b	Would you like to receive X payment in 4 weeks **and** Y payment in 8 weeks	1. 225 and 0 birr 2. 113 and 125 birr 3. 0 and 250	Only 1 answer
D2c	Would you like to receive X payment in 4 weeks **and** Y payment in 8 weeks	1. 200 and 0 birr 2. 100 and 125 birr 3. 0 and 250 birr	Only 1 answer
D2d	Would you like to receive X payment in 4 weeks **and** Y payment in 8 weeks	1. 175 and 0 birr 2. 88 and 125 birr 3. 0 and 250 birr	Only 1 answer
D2e	Would you like to receive X payment in 4 weeks **and** Y payment in 8 weeks	1. 150 and 0 birr 2. 75 and 125 birr 3. 0 and 250 birr	Only 1 answer

B. Task over long time period

We then follow Andreoni et al. (2015) to estimate time preferences parameters in the the optimal demand for sooner payment using Nonlinear Least Squares. Then, we create an

indicator variable equals 1 when a trader is present biased (i.e., $\beta < 1$). A present-biased ($\beta < 1$) trader allocates more to the sooner payment date when the sooner payment date is the current period than when both payment dates are in the future.

Risk Preferences

We used a survey-based measure of risk preferences based on Binswanger (1980) and Cole et al. (2013). We asked traders about a hypothetical wheat sale. We asked them to select which of the six hypothetical options they would prefer for this transaction. In the first payout they would be certain to receive 280 Birr for 10kg of wheat. In the second, they would have an equal chance of receiving 210 or 330 Birr. The subsequent four payouts are increasing in both mean and variance. We construct a risk aversion indicator variable equals 1 for traders who choose the safest lottery.

Loss Aversion

We used a survey-based measure of loss aversion from lotteries choice as in Binswanger (1980) and Cole et al. (2013). We asked traders about a hypothetical 250 Birr earnings they can increase by playing a coin tossing game. However, there are both a chance of increasing and a risk of losing some of this earning. We asked them to select which of the five hypothetical option they would prefer. In the first payout they would be certain to earn 250 Birr. In the second, they would have an equal chance of losing 50 Birr or winning 400 Birr. After that, there are three more payouts, which increase in both mean and variance. We use two variables capturing loss aversion. First, a dummy variable equals 1 if a trader chose the safest lottery (i.e., earning 250 Birr with certainty). Second, a continuous measure increasing with loss aversion equals to $\frac{\Delta \mathbb{E}[\text{Earning}]}{\Delta \text{Risk}}$.

References

Andreoni, James, Michael A Kuhn, and Charles Sprenger (2015). "Measuring time preferences: A comparison of experimental methods". In: *Journal of Economic Behavior & Organization* 116, pp. 451–464.

Binswanger, Hans P. (1980). "Attitudes toward risk: Experimental measurement in rural India". In: *American Journal of Agricultural Economics* 62.3, pp. 395–407.

Cole, Shawn, Xavier Giné, Jeremy Tobacman, Petia Topalova, Robert Townsend, and James Vickery (2013). "Barriers to household risk management: Evidence from India". In: *American Economic Journal: Applied Economics* 5.1, pp. 104–135.