It's All Fun and Games? The Persistent Treatment Effects of Willingness-to-Pay Experiments

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Abstract

Willingness-to-pay (WTP) experiments have been widely used to assess demand for a variety of products. Do they also generate persistent treatment effects? We answer this question using a randomized controlled trial of a baseline WTP experiment, combined with in-person and phone survey data over a four-year period. We find that a simple experiment leads to positive and persistent effects on adoption and usage of an improved storage technology, as well as disadoption of traditional technologies. These results are primarily driven by households who experienced the product, rather than information or salience. Failing to account for demand elicitation experiments conducted at baseline may affect the external validity of the broader experiments in which they are embedded.

KEYWORDS
Willingness to pay, Becker-DeGroot-Marschak, Field Experiment, persistent treatment effects, agriculture

JEL CODES
O12, O13, C93, D44

WORKING PAPER 714 · FEBRUARY 2025

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Jenny C. Aker, Brian Dillon, Leticia Donoso-Peña, and Anne Krahn. 2025. "It's All Fun and Games? The Persistent Treatment Effects of Willingness-to-Pay Experiments." CGD Working Paper 714. Washington, DC: Center for Global Development. https://www.cgdev.org/publication/its-all-fun-and-games-persistent-treatment-effects-willingness-pay-experiments

We are grateful for comments from seminar participants at Oxford University, Tilburg University, Yale University, the University of Urbana-Champagne Illinois, CSAE and NEUDC. This research is funded by J-PAL and CEGA's Agricultural Technology Adoption Initiative (ATAI) with generous support from the Bill & Melinda Gates Foundation and UK Aid.

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1 Introduction

Willingness-to-pay (WTP) experiments have been widely used to assess demand for a variety of goods and services in low-income countries, ranging from insecticide-treated bednets to human capital goods and market information services (Berry et al., 2020; Channa et al., 2019; Cole et al., 2020; Lybbert et al., 2018; Dizon-Ross and Jayachandran, 2023; Aker et al., 2020; Burchardi et al., 2021). Such studies typically aim to elicit WTP at *baseline*, prior to a given policy, or *after* an intervention, in order to determine whether and how the intervention affected demand (Dupas, 2014; Ben Yishay et al., 2017; Berkouwer and Dean, 2022; Berry and Mukherjee, 2019)

Beyond estimating demand curves, such experiments can address important barriers to technology adoption, either by providing information on the technology, access to it, or increasing its salience. As a result, the WTP experiment itself may serve as a treatment, thereby having substantial and persistent effects on outcomes. Yet few, if any, studies estimate the stand-alone treatment impacts of demand elicitation experiments.

This paper aims to fill this gap by estimating the dynamic impacts of a WTP experiment for an improved storage technology in Niger.[1] By randomizing access to the game, we find that the experiment alone significantly modified households' behavior in the short-, medium- and long-term: 92% of households owned the technology nine months after the game, dropping to 67% more than three years later, primarily because the technology fully depreciated. As a result, farmers in treatment villages disadopted other storage technologies, including dangerous pesticides, and suffered fewer storage losses. These results persisted 3.5 years after the initial experiment, beyond the traditional "shelf-life" of the technology. We do not find impacts on other downstream outcomes, nor does the experiment appear to crowd in additional demand for the new technology.

What are the channels through which the effect of a one-time WTP experiment persists? The experiment could have encouraged sustained adoption in several ways, via *information* about the product, *experience* with it, increased *salience* at a key moment or greater *enthusiasm* due to the nature of the game. To partially disentangle the first two mechanisms, we exploit the random draw price during the game as an instrument for winning the technology. We find that the results are significantly stronger for winners, suggesting that our findings are partially driven by experience with the product, rather than information. While the experiment made storage decisions more salient during the first year, this effect did not persist. Finally, we do not find evidence of a "gaming" effect on non-winners.

[1] The specific technology is the Purdue Improved Cowpea Storage (PICS) bag, a hermetically-sealed bag that can kill pests without the use of dangerous pesticides, namely, rat poison.

Our paper's main contribution is to quantify the treatment effects of commonly-used WTP experiments on adoption outcomes. The standard approach in the literature is to use WTP experiments to elicit willingness to pay from *all* households for a specific good at baseline (Hidrobo et al., 2022; Aker et al., 2020; Channa et al., 2019; Dupas, 2014), or after providing information, credit or subsidies for the product (Dupas, 2014; Balew et al., 2024; Jia and McNamara, 2024; Bensch and Peters, 2017; Fu-ning LI, 2024). Similar to the literature on the impact of being surveyed on respondents' behavior (Zwane et al., 2011; Treurniet, 2023), we show that demand elicitation experiments, on their own, can have substantial and persistent impacts on technology adoption.

Our study also fits into the broader literature on the dynamic and persistent impacts of short-run interventions. Such studies find that one-time subsidies can have persistent effects on adoption, in part due to learning and spillovers (Dupas, 2014; Bensch and Peters, 2017; Carter et al., 2021; Deutschmann, 2024; Balew et al., 2024). By using in-person and phone surveys over a four-year period, we are similarly able to document the dynamic and long-run treatment effects of a one-time experiment. Unlike those studies, however, we do not find evidence of learning or spillovers, perhaps because baseline knowledge of the product was high.

Finally, our findings suggest that demand elicitation experiments can potentially alter the external validity of the studies in which they are embedded, especially if conducted prior to an intervention. This problem has an easy fix: By measuring demand in a random subsample at baseline, researchers could test whether WTP elicitation affects adoption outcomes.

The remainder of the paper is organized as follows. Section 2 describes the experimental design, data and empirical strategy, whereas Section 3 presents the key results. Section 4 concludes.

2 Experimental Design and Data

2.1 The WTP Experiment

Our primary intervention is a WTP experiment embedded in a household survey. The experiment was a two-stage, incentive compatible variant of the Becker-Degroot-Marschak (BDM) (Becker et al., 1964) mechanism designed to elicit respondents' WTP for an improved storage technology. The technology is a hermetically-sealed bag that can store commodities such as cowpeas and maize without pesticides, and lasts *at least* three agricultural seasons before needing to be replaced (Aker et al., 2023; Omotilewa et al., 2018).[2]

After presenting the respondent with the technology and explaining its attributes, the respondent was asked whether he or she would be willing to purchase the good at a series of prices in increasing order from zero to above market price.[3] The respondent was informed that, after the price sequence, one price would be randomly drawn, and he or she would have the opportunity to purchase the good at the drawn price if his or her maximum WTP was at or above that price. The enumerator explained the process in detail and confirmed the respondent's maximum WTP prior to the random draw. If the respondent won, the sale took place after a short "cooling off" period, approximately one hour. Unlike other studies that have had "decliners" – those participants who refused to pay the drawn price if they won – all of the respondents paid if they won in our context.[4] Respondents were not compensated for their participation in the game nor the survey.

The WTP experiment was implemented over a four-week period in November and December 2020, immediately after the harvest and during the baseline of a broader study designed to address barriers to the adoption of the hermetically-sealed bag. The WTP experiment was also timed to ensure that the technology was salient for households as they were making storage decisions.[5] Data collection activities are provided in Appendix Table A1.

How might the WTP experiment affect demand for a new technology? There are a number of ways. First, as the game provides *information* about the technology and how to use it, this could address an important barrier to adoption, especially for those who had never heard about the technology. Second, since the technology is an experience good, those who win the game are able to learn by using it. Third, the timing of the experiment (immediately after the harvest) may make storage more *salient*, thereby bringing storage expenditures top of mind, at least for the first year. And finally, similar to other behavioral experiments, playing the game might generate *excitement* about the technology, thereby encouraging sustained usage (Janzen et al., 2021). While all of these factors would potentially *increase* demand for the technology, the WTP experiment could also dampen demand if households purchased at subsidized prices, thereby reducing the "sunk cost effect" (Ashraf et al., 2010; Cohen and Dupas, 2010). In addition, since the technology lasts for three years, if the experiment does

[2]Other commonly-used storage technologies are nylon bags with pesticides, which last one year, and 20-kg plastic jugs, which can last up to five years.

[3]At the time of the survey, the average market price for the technology was 1000 CFA (2 USD), but was available on fewer than 10% of markets. We included 5000 CFA in the price list in order to set the intercept.

[4]13-15% of the sample in (Meriggi et al., 2021; Grimm et al., 2020) were decliners. While we had no decliners, 1.5% of participants refused to play the game.

[5]The WTP elicitation was conducted in the context of a larger experiment, which provided information to farmers and traders about the improved storage technology and its relative costs with alternative technologies. These interventions took place approximately one year after the WTP experiment, and the experiments were cross-randomized with the WTP experiment.

not crowd in demand for an additional product, the experiment could reduce market demand, thereby reducing supply on local markets.

2.2 Experimental Design

In November 2019, we identified 220 villages in the Maradi and Zinder regions of Niger. Villages were stratified by region and their associated market's size before being randomly assigned to either the treatment (*WTP*) or control (*no WTP*).[6]

Within each village, we conducted a random walk and randomly chose 12 households per village, stratified by gender, interviewing either the primary male or primary female within the household. The respondent sampling was designed to be balanced by gender. As over 99% of households planted cowpea and hence had the potential to store, there were no inclusion criteria in the sample. This resulted in a sample of 2,639 households.

2.3 Data

Household Surveys The data in this paper are comprised of three in-person household surveys and one phone survey. The first in-person survey took place in December 2020. The survey asked questions about agricultural production, storage, knowledge of and experience with the storage technology. Enumerators conducted the WTP experiment at this time.[7]

A second in-person survey was conducted in September 2021, nine months after the baseline survey and WTP experiment. These surveys took place immediately prior to the harvest (and the broader experiment), and asked a limited number of questions about households' agricultural storage and their use of the improved storage technology.

We conducted a final in-person survey in December 2022 and a phone survey in March 2024, approximately two and 3.5 years after the initial intervention, respectively. The final in-person survey asked a number of questions about production, storage and marketing, whereas the phone survey primarily asked about households' production and storage behaviors. The type and timing of each survey, along with the number of observations, is provided in Table A1.

[6]The randomization resulted in 107 villages assigned to treatment and 113 to control. The slight imbalance was due to the modifications to the village sample during the baseline. A total of 226 villages were originally identified during the census and randomly assigned to treatment and control. Six villages were dropped from the sample, as they were located in Nigeria.

[7]The baseline survey was originally scheduled for March 2020 but was suspended due to the COVID-19 pandemic. The December 2020 survey thus followed strict health protocols. While schools were closed in Niger between March and June 2020, no other significant lockdowns or border closures occurred that may have affected agricultural production, storage or marketing.

Baseline Balance and Attrition Table A2 presents the baseline characteristics for our sample. Focusing on the control group, the average age of the respondent was 41 years and 68% of the households owned a mobile phone. Almost all households harvested cowpea in the prior agricultural season, producing 160 kg on average. 72% stored cowpea, primarily in normal bags (27%) and plastic jugs (40%). Only 7% stored cowpea in hermetically-sealed bags in the prior season. Conditional on storage, respondents spent 977 CFA (1.95 USD) per 100kg of cowpea stored in the past agricultural season, regardless of the technology used. 67% of respondents had heard of the improved storage technology at baseline, and 24% had previously used it. Households also had remarkably accurate beliefs about the depreciation rates of the traditional and "new" technologies. The treatment and control groups are similar along observable dimensions: Of the 30 variables tested, only 1 coefficient was statistically significant at the 10% level.

Of the original 2,639 households, 89% were tracked across all survey rounds (Table A3). The only differential attrition occurs during the first follow-up survey, whereby households in WTP villages were 2 percentage points more likely to attrit than those in the control.[8] As this survey round is not the primary focus of this paper, we do not report the corrections for differential attrition for that survey round.

2.4 Empirical Strategy

We estimate the impact of being assigned to the WTP experiment using the following specification:

$$Y_{iv} = \alpha_1 + \beta_1 WTP_v + \delta_1 Y_{i0} + \theta_s + \epsilon_{iv} \tag{1}$$

where Y_{iv} is the outcome of interest (such as adoption, usage and storage behavior) for individual i in village v. WTP is village-level assignment to the WTP experiment, θ_s is stratification (region and market size) fixed effects and Y_{i0} is the baseline value of the outcome variable.[9] We cluster our standard errors at the village level. For surveys that took place after the broader experiment (the second and third survey rounds), we control for the additional treatment in a "short" model, and report the results from the fully interacted "long" model in the Appendix.[10]

[8]The relatively lower response rate in the 2022 survey was due to a data collection error, whereby data were not collected from two villages.

[9]While some outcomes have low autocorrelation (e.g., storage losses and duration), others have high autocorrelation (e.g., storage practices). Thus, we use an ANCOVA specification for the results in this paper, but also conduct robustness checks using a first-differenced specification.

[10]Muralidharan et al. (2023) show that t-tests using fully saturated models provide valid inferences, whereas t-tests using "short" models can yield higher power if the interaction terms are zero. Although none of

To disentangle whether the impacts are primarily due to information about or experience with the technology, we use the variation from the randomly-drawn price during the second stage of the WTP game as an instrument for the likelihood of winning the technology, using the following specification:

$$Y_{iv} = \alpha_2 + \beta_2 \widehat{Won\ Game}_{iv} + \gamma_2 Max\ WTP_{iv} + \delta_2 Y_{i0} + \theta_s + \epsilon_{iv} \quad (2)$$

$$Won\ Game_{iv} = a + bDrawn\ Price_{iv} + \delta_3 Y_{i0} + \theta_s + \phi_2 Max\ WTP_{iv} + \nu_{iv} \quad (3)$$

where $Won\ Game$ is a binary variable equal to 1 if individual i won the game, 0 otherwise; $Drawn\ Price$ is the randomly drawn price; and $Max\ WTP$ is the individual's highest WTP bid price. The coefficient on β_2 is thus the treatment effect for the compliers, those who obtained information on the technology and had access to it via the game.[11]

3 Results

3.1 Willingness to Pay for the Technology

Figure 1 shows the inverse demand curves derived from the WTP experiment. Overall, mean WTP for the entire sample is 563 CFA (USD 1), about 56% of the average retail sales price, and 42.5% of those who played the game won the technology.[12] Demand is relatively inelastic at lower prices (Figure A1): take-up is universal when the technology is free and drops to 92% when the price goes to 250 CFA (USD .25). It then falls substantially after this point, dropping to 72% when the price goes to 400 CFA (USD .80), and 38% when the price crosses the 600 CFA (USD 1.20) threshold. There are no significant differences in WTP by either region (Panel B) or gender (Panel C), despite the fact that cowpea production is higher in one region, and women are traditionally more credit-constrained in this context.[13]

Nine months after the initial experiment, 92% of those who played and won the game still owned the technology, with 67% reporting storing in it during the prior agricultural season

our interaction terms are statistically significant, the results presented in the body of this paper should be interpreted as composite treatment effects.

[11]As we are controlling for the baseline outcome variable in each specification, the estimation of our first stage changes slightly for each regression. As a result, the F-statistic from our first stage is not constant across all regressions.

[12]Only 10% of markets located near villages in our sample sold the technology at baseline.

[13]Appendix Table A4 shows the correlates of respondents' WTP. The only statistically significant correlates of WTP are mobile phone ownership (as a proxy for wealth) and the amount of cowpea produced in the year of the survey.

(Table A5, Panel A).[14] The primary reasons that households did not use the technology were the timing of the game (e.g., households who played soon after the harvest were more likely to store) and the quantity produced (e.g., households who produced more than 100 kg at baseline were more likely to store in the technology). More than three years later, ownership amongst those who played the game fell to 63% (Panel B), primarily due to deterioration of the bag, yet 81% of those who had the bag still used it. While the average duration of the technology is three years, this suggests that households continued to use it beyond its "shelf-life."[15]

3.2 Impacts of the WTP Experiment Over Time

Table 1 shows the impact of the WTP experiment on households' storage choices, storage and health outcomes. In the first year after the intervention, the WTP experiment reduced the likelihood of purchasing an additional hermetically-sealed bag, but did not affect storage losses or the duration of storage, perhaps because only 2/3 of households had used it during the prior season (Panel A). Yet two years after the experiment, there was a significant impact upon households' storage behavior (Panel B): Households in WTP villages were 13% points more likely to store in the improved technology and 14% points less likely to use traditional storage technologies (Columns 1 and 2). As a result, they were 10% points less likely to use pesticides during storage and less likely to suffer storage losses, although the latter is not statistically significant at conventional levels. These effects are large in magnitude, ranging from 25-34% of the control mean. Yet there were no impacts on storage duration, health outcomes associated with pesticide consumption or demand for an additional product.[16]

Many of these results persisted 3.5 years after the experiment (Panel C): Households in WTP villages continued to use the new technology and shifted away from traditional technologies and pesticide use. The magnitudes of these effects are smaller, in part due to a significant increase in adoption in the control group over time, from 7% at baseline to over 46% 3.5 years later.[17] Unlike other studies on technology adoption, the experiment did not crowd in new purchases of the technology after the third year(Figure A4) (Omotilewa et al., 2019).[18]

[14]Among the 8% who no longer owned the technology, the primary reason was that it had been destroyed.

[15]While usage is slightly correlated with WTP in the short-term, this does not persist for owning the technology in the longer-term (Figure A2). Visual inspection of a subset of bags that were inspected suggested that they were still in "good" condition for storage, namely, that there were no holes or tears.

[16]There were no heterogeneous effects on storage losses, duration or additional purchases by key characteristics, such as gender, mobile phone ownership or agricultural production (TableA6).

[17]We do not find spillovers across villages that could potentially explain this adoption increase, but rather an increase in the availability of the bags on the market.

[18]The results in Table 1 are all conditional on the other treatment and hence are composite effects.

3.3 Information, Experience, Salience or Enthusiasm?

What explains the persistent effects of this game? As outlined above, the experiment could have encouraged sustained adoption via a number of pathways. We attempt to address each of these in turn.[19]

Information. While the WTP provided farmers with information about the technology, information does not seem to be a primary barrier to adoption. At baseline, over 67% of households had heard about the technology, and households had fairly accurate beliefs about its effectiveness. This was confirmed at follow-up: Those living in WTP villages did not have higher knowledge about the technical aspects of the technology as compared to those in control villages (Table A8, Panel A).

Experience. While all of those who played the game received information about it, only a subset won and hence were able to experience it. Table 2 estimates the additional effect of experiencing the product using equation (2). Overall, the results are consistent with those in Table 1, but stronger in magnitude. In the short-term (Panel A), households who played and won the game were significantly less likely to purchase an additional technology, and were less likely to suffer from storage losses. Two years later, households continued to use the new technology (Panel B), thus shifting away from using traditional technologies and pesticides. These results persisted for most outcomes after three years (Panel C). Winners were also 10 percentage points less likely to purchase an additional technology by the third year (Panel C, Column 6), in part because they kept the technology.[20] These results are largely robust to estimating the effects on the sample that excludes the other treatment (Table A9). Taken together, this suggests that experience with the technology was a key driver of the persistent effects of the experiment.

Salience. The timing of the experiment after the harvest may have made storage costs more *salient* for farmers, thereby bringing storage expenditures top of mind. We assess the importance of salience by estimating the impact of the *timing* of the experiment on adoption and usage. Using the dates of the baseline experiment in a particular village, we are able to

We therefore report the results of the fully interacted model in Table A7. With one exception, none of the interaction terms are statistically significant, and the coefficients on the WTP variable are large and statistically significant in the medium-term, and large but imprecise in the longer-term.

[19] Janzen et al. (2021) note three other mechanisms through which a behavioral game could influence behavior, namely, the length of the game, interactions with enumerators (who administer the game and survey questions) and the payout. Our game lasted an average of 30 minutes, and different enumerators were used for each survey round. Our results are also robust to the inclusion of enumerator fixed effects for a given round.

[20] Survey evidence suggests that those who won the technology had a positive experience with it: 80% of respondents thought the bag was high-quality and effective in preventing storage losses. Within WTP villages, there were no effects on the likelihood of storage or pesticide use by the bid price (Figure A3).

determine if the game was played immediately after the harvest (before storage decisions were made) or one month later, after many storage decisions were made. Households who played the game immediately after the harvest were more likely to store in the bag in the first year, but these results did not persist over time. There were also no effects on other outcomes by the timing of the baseline experiment (Table A6). This suggests that salience was important for usage in the short-term, but did not persist over time.

Enthusiasm. Given the body of literature on the use of behavioral games to spur adoption, the WTP experiment could have generated enthusiasm about the technology, thus leading to sustained adoption and usage. To test for this, we would ideally have wanted a treatment arm that provided information and access to the technology *without* the game (such as demonstrations and subsidized distribution), or a "placebo" WTP.[21] In the absence of this setup, we test for the impact of the game - which which we interpret as "enthusiasm" - in three ways. First, we ask households about their experience with the game – e.g., if they remember the game, their bid and drawn price, as well as other attributes. Second, to compare non-winners in WTP villages with (comparable) non-winners in control villages, we construct a bootstrapped sample of non-winners whose bid distribution matches that of the entire WTP sample, and compare the bootstrapped sample of non-winners with the pure control. And finally, we estimate a propensity score based upon observable determinants of the bid price, and match non-winners in WTP villages with comparable non-winners in the control.

Less than one year after the game, households had accurate recollections about their "winning" status: 41% of households recalled winning the game, as compared with 42% who won. Yet only 54% of those who won the game recalled the price at which they won (and hence paid). These results were slightly higher for those for whom the consumer surplus was higher (in other words, the bid price was substantially higher than the drawn price). This suggests that, while the households recalled the game, the details were not retained.

Appendix Table A10 shows the results from the bootstrapping and propensity score matching estimates for a subset of outcomes. With the exception of the short-term (Panel A), where non-winners in treatment villages were less likely to purchase a bag, there are no effects across the specifications on most of the outcomes of interest (Panels B and C).[22] Thus, while there may have been an effect from the game in the short-term, this suggests that a "gaming" effect is not a primary driver of the sustained effects.

[21]For example, Janzen et al. (2021) conduct a RCT that varies access to information, as well as information plus an experiential game on basic risk, including a placebo game.

[22]We would expect that any "gaming" effects would be strongest in the short-term. We only collected data for a small number of outcomes during this survey, which we report here. There were no consistent results on the broader set of outcomes in the medium- and long-term.

4 Conclusion

We revisit the use of WTP experiments in economics, using a different approach than in past studies: Varying access to the game at baseline and documenting the persistent impacts of the experiment over time. Overall, we find that the impacts of such experiments can be large and persistent: Despite a significant increase in technology adoption of the control over time, we find use of the technology 3.5 years after the experiment. These effects were stronger for those who experienced the good, namely, game-winners.

Despite these persistent effects on adoption, there were few effects on other downstream outcomes, such as storage losses, duration or illnesses. This could be due the fact that the magnitude of storage losses was relatively low (as alternative storage technologies are highly effective in reducing losses), or due to the idiosyncratic nature of agricultural production and storage. In addition, the experiment did not crowd in demand for a new technology after three years.

We provide suggestive evidence that experience with the product seems to drive persistent adoption, similar to the distribution of other experience goods (Bensch and Peters (2017). Nevertheless, we are unable to fully test whether the game itself generated enthusiasm for the product. A key question is whether we would see similar results if we simply provided information and access to technology in an interactive manner, but without the game.

Finally, and perhaps most importantly, our results suggest that researchers should be aware of the potentially large impacts of baseline WTP elicitation on adoption measures and other outcomes, and design experiments in such a way that allow these effects to be captured.

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Tables and Figures

Table 1: Intent to Treat (ITT) Effects of the WTP Experiment

Panel A: 9 months after WTP game

	(1) Purchased PICS bag last year	(2) HH suffered storage losses	(3) HH stored until hot season
WTP Assignment	-0.15***	-0.02	0.02
	(0.02)	(0.02)	(0.02)
Observations	2,393	2,164	2,164
Control Mean	0.270	0.200	0.720
Control SD	0.440	0.400	0.450

Panel B: 2 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH stored until hot season	(6) Purchased PICS bag	(7) Household experienced health symptoms
WTP Assignment	0.13***	-0.14***	-0.09***	-0.02	0.02	-0.01	0.01
	(0.03)	(0.03)	(0.02)	(0.01)	(0.02)	(0.03)	(0.02)
Observations	2,249	2,249	2,249	2,249	2,249	2,249	2,249
Control Mean	0.380	0.530	0.300	0.0800	0.760	0.370	0.0600
Control SD	0.490	0.500	0.460	0.270	0.430	0.480	0.240

Panel C: 3.5 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH store until hot season	(6) Purchased PICS bag	(7) Household experienced health symptoms
WTP Assignment	0.09**	-0.11***	-0.05**	-0.02*	-0.05	-0.03	-0.01
	(0.04)	(0.03)	(0.02)	(0.01)	(0.05)	(0.04)	(0.01)
Observations	2,354	2,354	2,354	2,354	2,354	2,354	2,354
Control Mean	0.460	0.460	0.250	0.0700	0.560	0.440	0.0300
Control SD	0.500	0.500	0.430	0.250	0.500	0.500	0.170

Notes: All panels show the results of estimating equation (1). We control for gender and stratification fixed effects, as well as the baseline value of the outcome variable. For Panels B and C, we control for the additional treatment implemented after the WTP experiment. We cluster our standard errors at the village level. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table 2: Local Average Treatment Effects (LATE)

Panel A: 9 months after WTP game

	(1) Purchased PICS bag last year	(2) HH suffered storage losses	(3) HH stored until hot season
Won WTP game	-0.11***	-0.17***	0.02
	(0.03)	(0.03)	(0.05)
Observations	1,135	1,010	1,010
Control Mean	0.16	0.20	0.69
Control SD	0.36	0.43	0.46
F-stat on instrument	1684	1423	1413

Panel B: 2 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH stored until hot season	(6) Purchased PICS bag	(7) Household experienced health symptoms
Won WTP game	0.29***	-0.27***	-0.15***	-0.03	0.04	-0.04	-0.03
	(0.05)	(0.04)	(0.03)	(0.02)	(0.04)	(0.04)	(0.02)
Observations	1,068	1,068	1,068	1,068	1,068	1,068	1,068
Control Mean	0.37	0.51	0.29	0.09	0.75	0.34	0.10
Control SD	0.48	0.50	0.45	0.28	0.43	0.47	0.31
F-stat on instrument	1438	1419	1425	1417	1423	1422	1421

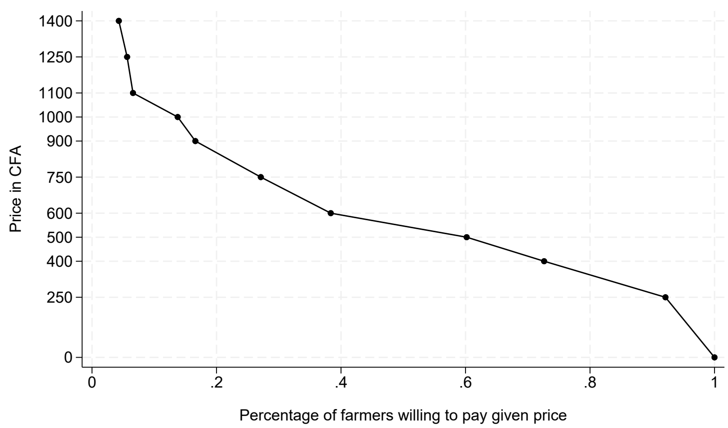
Panel C: 3.5 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH stored until hot season	(6) Purchased PICS bag	(7) Household experienced health symptoms
Won WTP game	0.14***	-0.08*	-0.08**	0.00	0.01	-0.10**	-0.02
	(0.05)	(0.04)	(0.03)	(0.02)	(0.04)	(0.04)	(0.01)
Observations	1,128	1,128	1,128	1,128	1,128	1,128	1,128
Control Mean	0.44	0.39	0.20	0.03	0.48	0.38	0.02
Control SD	0.50	0.49	0.40	0.17	0.50	0.49	0.15
F-stat on instrument	1746	1752	1772	1757	1767	1777	1720

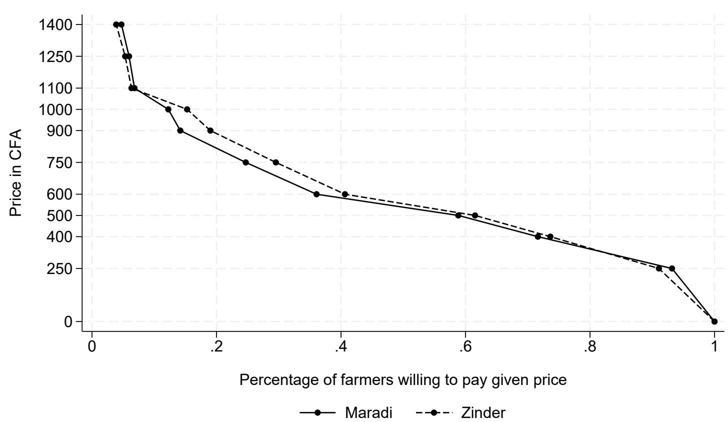
Notes: All panels show the results of estimating equation (2). We control for gender, the individual's maximum WTP at baseline, stratification fixed effects and the baseline value of the outcome variable. For Panels B and C, we control for the other treatment implemented after the WTP experiment. Robust standard errors clustered at the village level in parenthesis. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Figure 1: Inverse Demand Curves

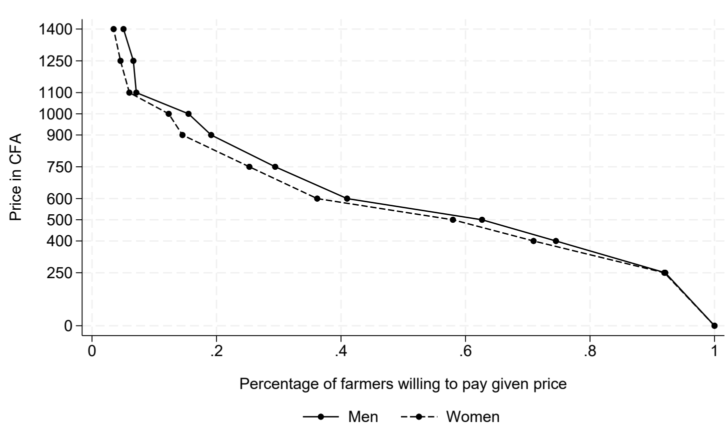
Panel A: Overall Demand



Panel B: By Region



Panel C: By Gender



Notes: Panel A displays the inverse demand curve in the entire sample, where an individual's WTP is reported on the vertical axis and percentage of individuals reporting a given WTP is reported on the horizontal axis. Panel B displays the inverse demand curves by region. Panel C displays the inverse demand curves by gender.

Appendix

Table A1: Data Collection

Survey Round	Dates	Observations
Baseline Survey	December 2020	2,639
Midline Survey	September 2021	2,326
Endline Survey	December 2022	2,249
Phone Survey	March 2024	2,354

Notes: Each number is the total sample size of households found by survey round.

Table A2: Baseline Balance

	(1) Control	(2) WTP	(3) N
Age	41.24	-0.64	2639
	(15.19)	(0.59)	
Female	0.50	0.00	2639
	(0.50)	(0.00)	
Household owns a cell phone	0.68	0.01	2639
	(0.47)	(0.03)	
Quantity in kg of cowpea harvested in 2020/2021	161.02	-7.08	2639
	(222.11)	(16.23)	
Household sold cowpea during the 2019/2020 harvest	0.64	-0.01	2639
	(0.48)	(0.03)	
Total number of markets where cowpea was sold during last harvest	0.60	0.02	2639
	(0.65)	(0.04)	
Stored cowpea in 2020/2021	0.72	-0.01	2639
	(0.45)	(0.03)	
Stored cowpea in any bag	0.34	0.00	2639
	(0.47)	(0.02)	
Stored in normal bags	0.27	0.00	2639
	(0.44)	(0.02)	
Stored in PICS bags	0.07	0.00	2639
	(0.25)	(0.01)	
Stored in bidon	0.40	0.01	2639
	(0.49)	(0.03)	
Number of PICS bags bought	0.15	-0.02	2639
	(0.86)	(0.04)	
Price per unit of PICS bags (CFA)	1020.25	-47.94	152
	(187.34)	(32.48)	
Total expenses (CFA) on cowpea storage per 100kg (CFA)	944.65	51.08	1874
	(3679.20)	(142.89)	
Respondent has heard about PICS bags	0.67	-0.01	2639
	(0.47)	(0.03)	
Respondent has used PICS bags at some point	0.24	-0.03	2639
	(0.43)	(0.03)	
9 month subj. depreciation rate, trad bags + pesticides	0.33	-0.02	2639
	(0.38)	(0.03)	
9 month subj. depreciation rate, PICS	0.03	0.01*	2639
	(0.11)	(0.01)	

Notes: Column 1 presents the mean of the dependent variable for villages not assigned to the willingness-to-pay (WTP) game (standard deviation in parentheses), Column 2 reports the coefficient from a regression of the dependent variable on an indicator variable for WTP (standard error in parentheses), controlling for strata fixed effects. Robust standard errors clustered at the village level presented in parentheses. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table A3: Attrition

	9 Months after WTP Game	2 Years after WTP Game	3.5 Years after WTP Game
	(1) September	(2) December	(3) March
WTP Assignment	0.02*	0.02	0.00
	(0.01)	(0.02)	(0.02)
Female(=1)	-0.05***	-0.03**	-0.01
	(0.01)	(0.01)	(0.01)
Zinder(=1)	-0.01	0.04*	-0.03
	(0.01)	(0.02)	(0.02)
Market size	-0.00	-0.01	0.01
	(0.01)	(0.02)	(0.02)
Other treatment assignment		-0.03	-0.03
		(0.03)	(0.02)
Dependent Variable Control Mean	0.08	0.14	0.11
R-Squared	0.01	0.01	0.00
Observations	2639	2639	2639

Notes: Columns 1-3 show the coefficients from regressing a variable for attrition on the WTP assignment indicator for each survey round, as well as stratification (region and market size) and gender controls. We cluster our standard errors at the village level. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table A4: Correlates of Willingness to Pay

	(1) Maximum WTP
Female	-13.56
	(37.44)
Age	-1.35
	(0.98)
Owns mobile phone	106.04***
	(36.40)
Number of letters respondent can read	-2.03
	(6.14)
Self-assessment of maths skills	10.42
	(27.21)
Stored cowpea in 2020	94.08
	(74.60)
Quantity in KG of cowpea harvested in 2020/2021	0.17**
	(0.08)
Quantity in KG of cowpea harvested in 2019/2020	0.00
	(0.10)
Stored cowpea in any bag	-14.83
	(74.83)
Total expenses on cowpea storage	0.02
	(0.02)
Respondent has used PICS bags at some point	54.85
	(36.59)
9 month subj. depreciation rate, traditional bags	-9.38
	(38.84)
9 month subj. depreciation rate, trad bags + pesticides	180.57
	(150.71)
9 month subj. depreciation rate, PICS	275.04
	(421.32)
Zinder region	-3.49
	(35.17)
Mean Maximum WTP	562.44
Observations	1068
R-Squared	0.06

Notes: Maximum WTP values are in CFA. We cluster our standard errors at the village level. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table A5: Summary Statistics

	Mean	Std. Dev.	N
Panel A: 2021			
Respondent won the technology	0.42	0.49	1,122
Respondent still owns it	0.92	0.27	468
Technology destroyed	0.58	0.5	38
Respondent stored in it	0.67	0.47	430
Panel B: 2024			
Respondent still owns it	0.63	0.48	510
Technology destroyed	0.88	0.32	168
Respondent stored in it	0.81	0.39	320

Notes: This table displays summary statistics collected during the surveys nine months and 3.5 years after the WTP experiment.

Table A6: Heterogeneous Effects

Outcome is:	Household suffered losses					Household stored until hot season				
Het var is:	Female	Cell phone	Store in traditional technologies	Produce > 100kg	Early WTP	Female	Cell phone	Store in traditional technologies	Produce > 100kg	Early WTP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: 9 months after WTP game										
WTP treatment	-0.06**	-0.02	-0.02	-0.02	-0.02	0.06*	-0.00	-0.02	0.00	0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.03)
Het variable	-0.05**	0.00	0.01	-0.03	0.01	0.04	0.03	0.07**	0.09***	0.05
	(0.02)	(0.02)	(0.03)	(0.03)	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)
WTP × Het var	0.06*	-0.02	0.00	-0.01	-0.02	-0.07*	0.05	0.07	0.03	0.03
	(0.03)	(0.03)	(0.03)	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
Panel B: 2 years after WTP game										
WTP treatment	-0.01	-0.02	-0.01	-0.03	-0.02	0.01	0.01	0.06*	-0.00	0.00
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.03)	(0.04)	(0.03)	(0.03)	(0.03)
Het variable	0.01	0.01	0.04**	-0.01	-0.09***	-0.07***	0.03	0.10***	0.08***	-0.08
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.05)
WTP × Het var	-0.02	0.00	-0.02	0.01	-0.01	0.02	0.01	-0.06*	0.04	0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)
Panel C: 3.5 years after WTP game										
WTP treatment	-0.02*	-0.01	-0.02	-0.00	-0.01	-0.06	-0.09	-0.04	-0.10*	-0.09
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.05)	(0.07)	(0.06)	(0.05)	(0.06)
Het variable	-0.01	0.01	-0.01	0.01	0.04*	-0.05**	0.03	0.05	-0.01	-0.23***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.04)	(0.04)	(0.04)	(0.08)
WTP × Het var	0.01	-0.01	0.01	-0.02	-0.02	0.01	0.06	-0.02	0.10*	0.09
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.06)	(0.05)	(0.06)	(0.11)

Notes: All panels show the results of regressing the outcome of interest on their village's WTP assignment interacted with the variable specified in the column title. We add stratification fixed effects. For Panels B and C, we control for the other treatment implemented after the WTP experiment. We cluster our standard errors at the village level. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table A7: Fully Interacted Model

Panel A: 2 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH store until hot season	(6) Purchased PICS bag
WTP Assignment	0.10*	-0.16**	-0.13***	0.04	0.03	-0.08
	(0.06)	(0.07)	(0.05)	(0.04)	(0.06)	(0.06)
Any treated group (=1)	0.03	-0.03	-0.02	0.01	0.02	0.01
	(0.04)	(0.04)	(0.03)	(0.02)	(0.04)	(0.04)
WTP*Treatment Status	0.02	0.01	0.01	-0.02*	-0.00	0.03
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Observations	2,249	2,249	2,249	2,249	2,249	2,249
Control Mean	0.379	-0.0437	0.0671	0.00875	0.0933	0.321
Control SD	0.486	0.667	0.528	0.386	0.554	0.492

Panel B: 3.5 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH store until hot season	(6) Purchased PICS bag
WTP Assignment	0.12	-0.13	-0.12**	-0.00	0.04	-0.05
	(0.09)	(0.09)	(0.06)	(0.03)	(0.12)	(0.09)
Any treated group (=1)	-0.00	-0.04	-0.07**	-0.01	0.03	-0.05
	(0.06)	(0.06)	(0.04)	(0.02)	(0.08)	(0.06)
WTP*Treatment Status	-0.01	0.01	0.03	-0.01	-0.04	0.00
	(0.03)	(0.03)	(0.02)	(0.01)	(0.04)	(0.03)
Observations	2,354	2,354	2,354	2,354	2,354	2,354
Control Mean	0.461	-0.126	0.0229	-0.0115	-0.106	0.395
Control SD	0.499	0.720	0.530	0.379	0.705	0.545

Notes: All panels show the results of regressing the outcome of interest on their WTP assignment, the other treatment and the interaction between the two. We control for gender, stratification fixed effects and the baseline values of the outcome variable. We cluster our standard errors at the village level. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table A8: Effects on Learning, 2 years after WTP game

Panel A: Intent to Treat (ITT)

	(1) Knowledge score about PICS bag (out of 4)
WTP Assignment	0.01
	(0.04)
Observations	2,249
Control Mean	3.309
Control SD	0.756

Panel B: Local Average Treatment Effect (LATE)

	(1) Knowledge score about PICS bag (out of 4)
Won WTP game	0.02
	(0.07)
Observations	1,068
Control Mean	3.230
Control SD	0.830
F-stat on instrument	1420

Notes: Panel A shows the results of estimating equation (1), while Panel B shows the results of estimating equation 92). We control for gender and stratification fixed effects. As we do not have a baseline measure of knowledge, we also control for the baseline measure of beliefs about the technology. We cluster our standard errors at the village level. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table A9: LATE Effects in Non-Treatment Villages

Panel A: 9 months after WTP game

	(1) Purchased PICS bag last year	(2) HH suffered storage losses	(3) HH stored until hot season
Won WTP game	-0.12**	-0.14**	0.04
	(0.05)	(0.06)	(0.08)
Observations	329	329	329
Control Mean	0.160	0.230	0.690
Control SD	0.370	0.420	0.460
F-stat on instrument	381.1	384.8	393

Panel B: 2 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH stored until hot season	(6) Purchased PICS bag	(7) Household experienced health symptoms
Won WTP game	0.39***	-0.28***	-0.16**	-0.01	0.02	0.04	-0.02
	(0.10)	(0.09)	(0.06)	(0.05)	(0.08)	(0.09)	(0.05)
Observations	291	291	291	291	291	291	291
Control Mean	0.270	0.540	0.320	0.130	0.720	0.250	0.0800
Control SD	0.440	0.500	0.470	0.330	0.450	0.440	0.270
F-stat on instrument	263.3	251	265.3	256.5	260.5	262.7	266

Panel C: 3.5 years after WTP game

	(1) Stored in PICS bags	(2) Stored in traditional technologies	(3) Used pesticides for cowpea storage	(4) HH suffered storage losses	(5) HH stored until hot season	(6) Purchased PICS bag	(7) Household experienced health symptoms
Won WTP game	0.22***	-0.24***	-0.05	-0.02	-0.03	0.01	-0.03
	(0.08)	(0.08)	(0.06)	(0.03)	(0.09)	(0.07)	(0.03)
Observations	323	323	323	323	323	323	323
Control Mean	0.390	0.460	0.230	0.0500	0.500	0.350	0.0100
Control SD	0.490	0.500	0.420	0.220	0.500	0.480	0.120
F-stat on instrument	320.3	313.8	339.2	336.4	329.4	321.3	334.3

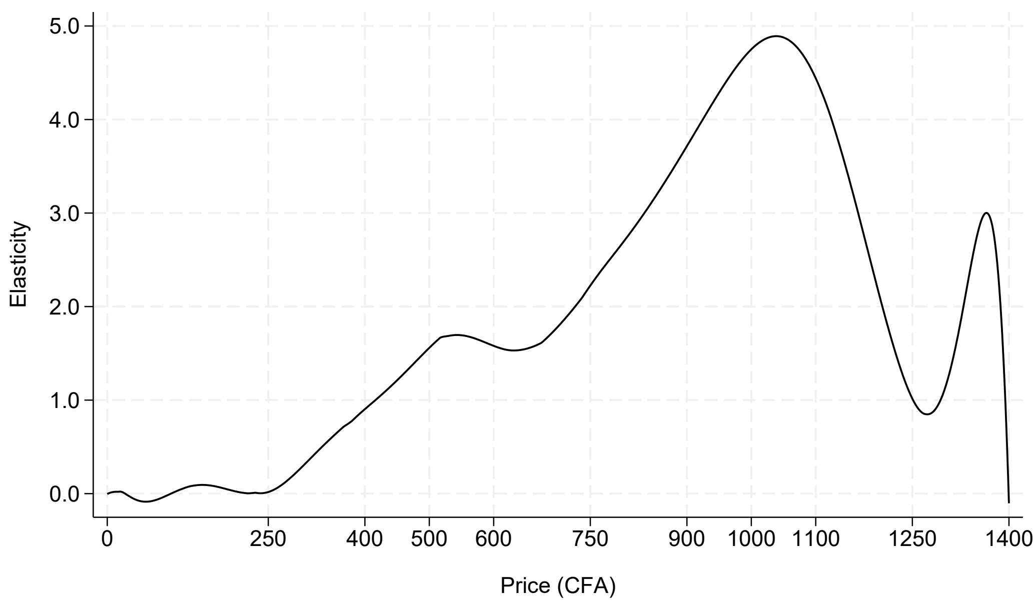
Notes: All panels show the results of estimating equation (2). We control for gender, the individual's maximum WTP at baseline, stratification fixed effects and the baseline value of the outcome variable. For Panels B and C, we control for the other treatment implemented after the WTP experiment. Robust standard errors clustered at the village level in parenthesis. ***, **, * denote statistical significance at the 1, 5, 10 percent levels, respectively.

Table A10: Effects of Playing the Game

	(1) Purchased PICS bag last year	(2) HH suffered storage losses	(3) HH stored until hot season
Panel A: 9 Months after the Experiment			
Bootstrapping	-0.11***	-0.01*	-0.03
Propensity Score Matching	-0.09***	0.03	-0.02
Panel B: Two Years after the Experiment			
Bootstrapping	-0.03	0.00	-0.02
Propensity Score Matching	-0.01	-0.01	-0.00
Panel B: 3.5 Years after the Experiment			
Bootstrapping	-0.02	-0.01	-0.06
Propensity Score Matching	0.00	-0.02	-0.07

Notes: This shows the results of a regression of inverse probability using the propensity score on non-winners in WTP villages and non-winners in non-WTP villages. Robust standard errors clustered at the village level in parenthesis. *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.001 level, respectively.

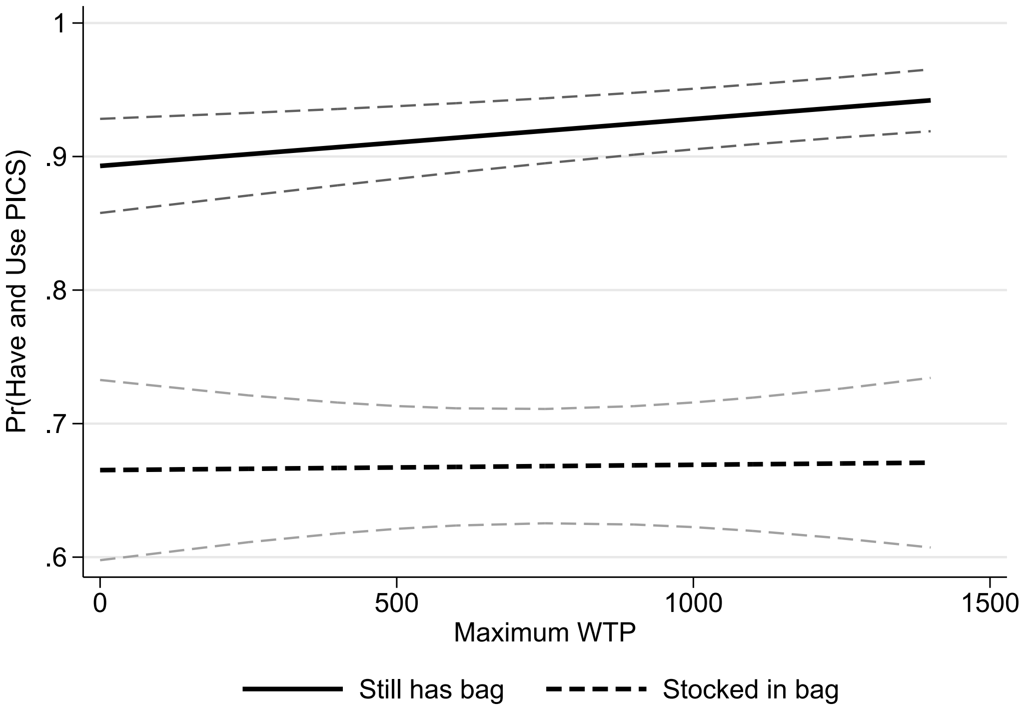
Figure A1: Elasticity of Demand



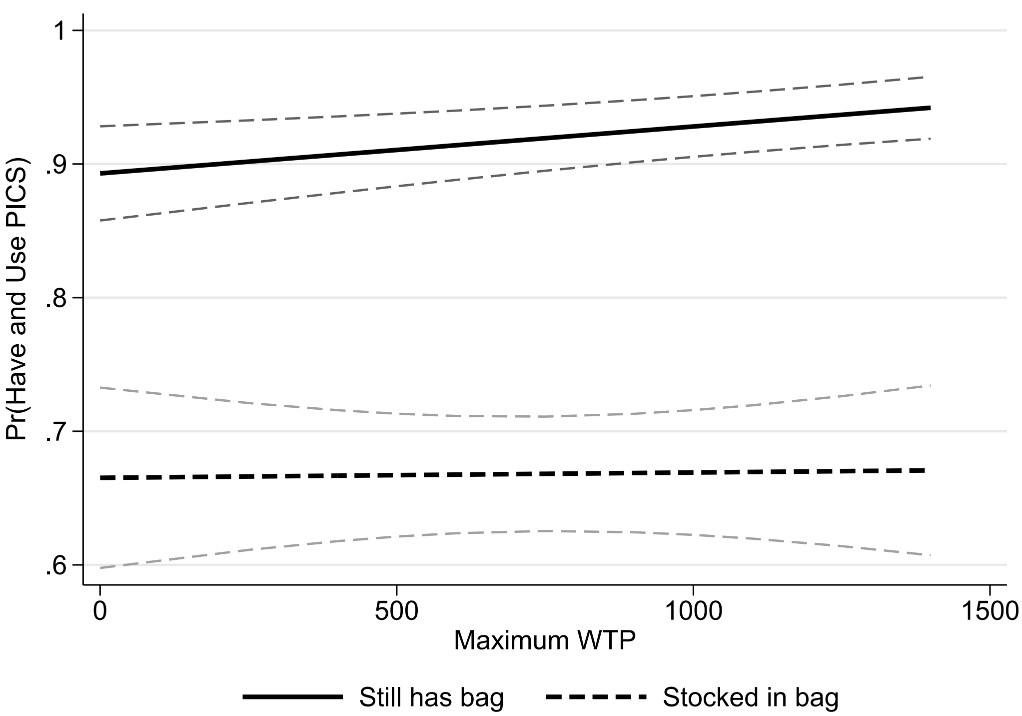
Notes: Demand elasticities are calculated by local polynomial regression using an Epanechnikov kernel, following Berry et al. (2020).

Figure A2: Ownership and Usage by Max. Willingness to Pay Price

Panel A: 9 months after WTP game



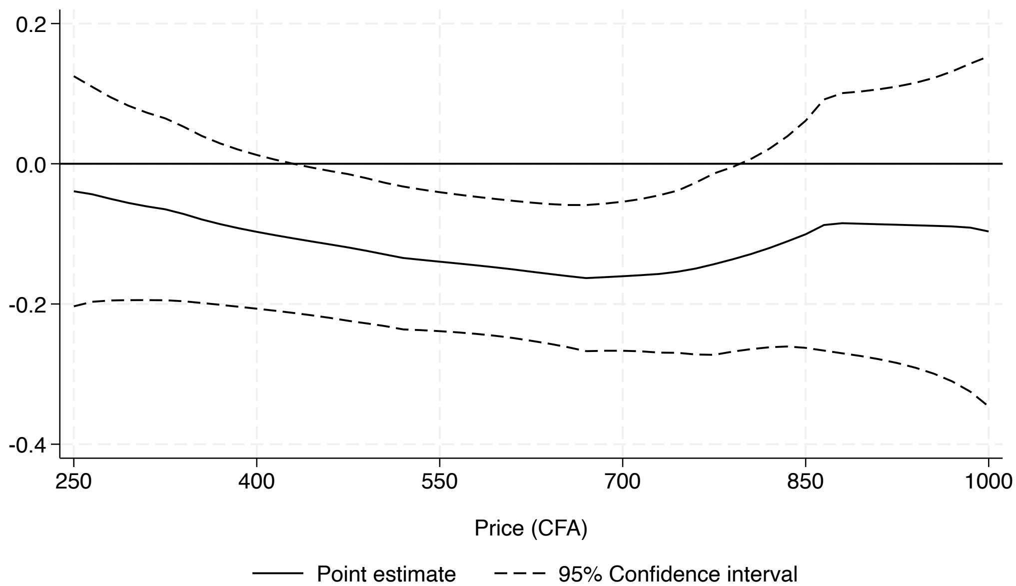
Panel B: 3.5 years after WTP game



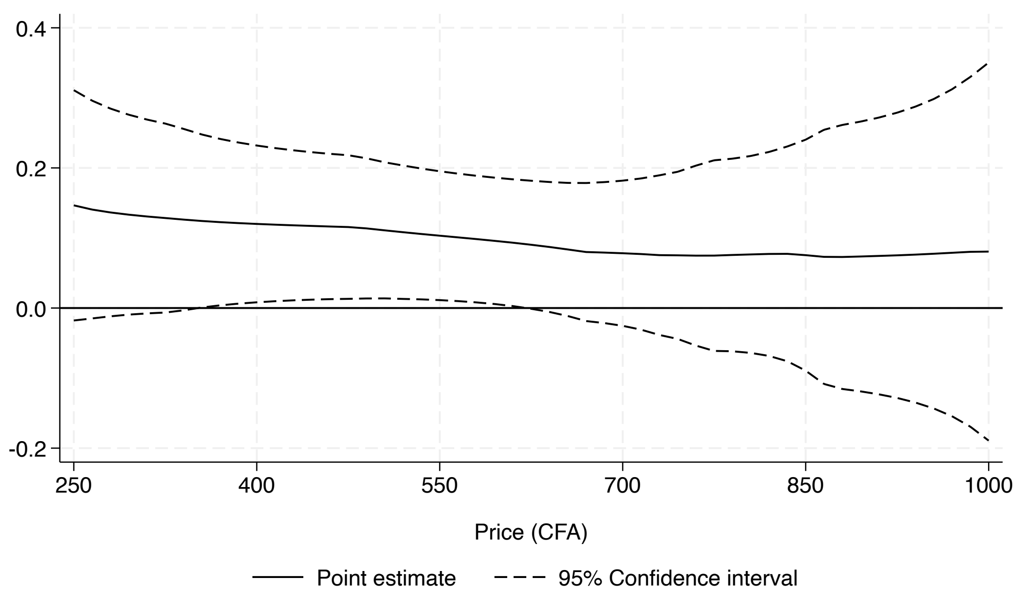
Notes: Panels A and B display how ownership (solid black line) and usage (dashed black line) varies by revealed maximum willingness to pay price. Regressions include stratification (region and market size) fixed effects.

Figure A3: Kernel IV Estimates of Treatment Effects in the Long-Term

Panel A: Storing in PICS Bag



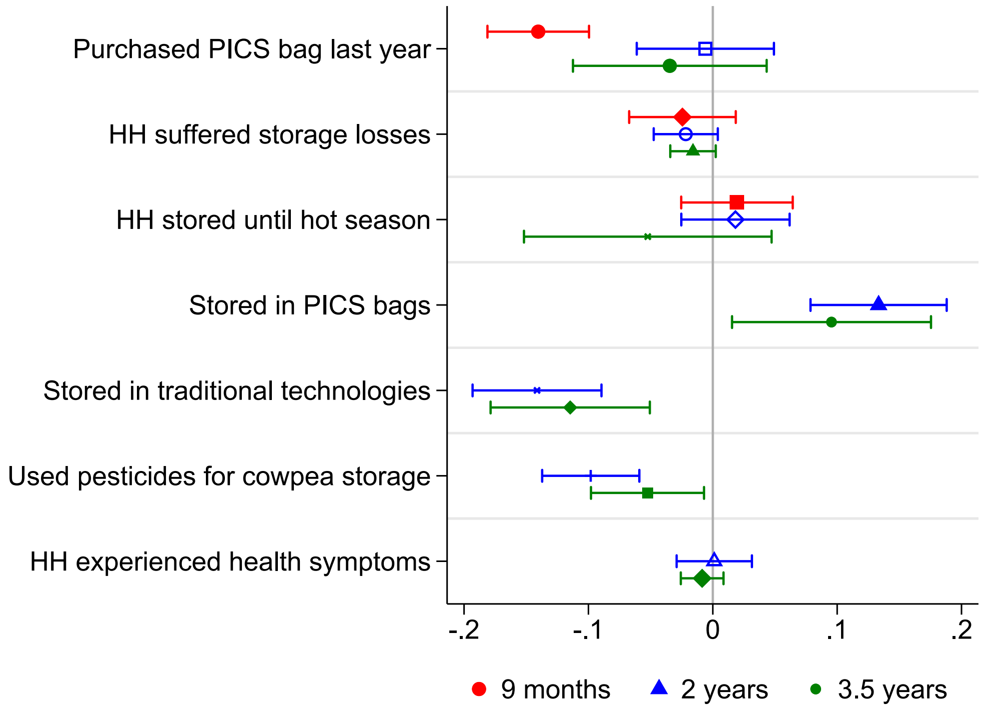
Panel B: Using Pesticides for Storage



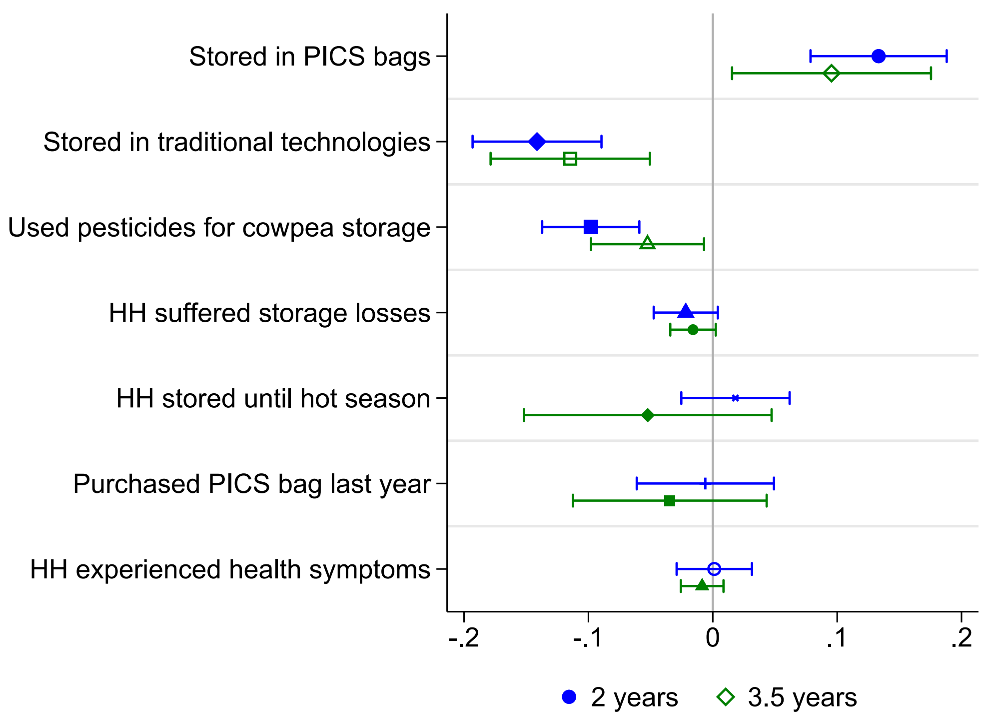
Notes: Panel A displays the estimated reduction in reported household diarrhea as a function of willingness-to-pay (WTP). Panel B displays the estimated season in which cowpea was sold as a function of WTP. In both graphs, these are two-stage least squares estimates at a WTP of 250 CFA to 1000 CFA in increments of 15 CFA. Observations are weighted by their distance from the evaluation WTP using Silverman's rule of thumb for the bandwidth and an Epanechnikov kernel. Standard errors are clustered at the village level.

Figure A4: Effects over Time

Panel A: All Periods



Panel B: Excluding 9 Months



Notes: Panel A displays the coefficients on the "WTP" variable for all regressions, controlling for strata fixed effects and clustering the s.e. at the village level. The second panel shows the coefficients from the same regressions, but only for the last two survey rounds.