Demand for Options as Price Insurance: Pre-Analysis Plan

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Abstract

Maize prices in Malawi frequently rise sharply between harvest and the lean season, but the size of the increase is highly volatile across years, exposing both net buyers and net sellers of the staple to substantial uninsured price risk. In practice, households lack access to standard financial products to protect against this risk. As a stand-in for a traditional insurance mechanism, we offer households simple bilateral option contracts on maize. We offer two types of contracts, calls that place a price ceiling on maize, and puts that create a price floor. We elicit incentivized willingness-to-pay (WTP) measures for these contracts from 224 households in Zomba District, Malawi. Each household completes Becker-DeGroot-Marschak elicitations for six contracts varying in type (call/put) and strike price, one of which is randomly selected to be offered at a randomly drawn premium. Primary outcomes are the level and distribution of WTP, and its gradient with respect to the strike price. Secondary outcomes include WTP relative to actuarially fair benchmarks, sensitivity of demand to deferred payment, and WTP to extend the coverage window.

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1 Introduction

Intra-seasonal commodity price volatility is a first-order risk for rural households in low-income countries. In East Africa, seasonal price spreads regularly reach 40 percent (Burke et al., 2019; Stephens and Barrett, 2010); in Malawi, where maize accounts for as much as 71 percent of household calories (Bliznashka et al., 2025), spreads frequently exceed 100 percent. The welfare cost of this volatility operates through two channels. First, the *level* of the seasonal price rise erodes real income for lean-season net buyers. Second, and distinctly, the *unpredictability* of the rise makes both storage and sales decisions risky. In data from IFPRI Malawi's Maize Price Monitor, lean-season prices vary widely season-to-season, ranging from a 20 percent increase in the "best" year to a 225 percent increase in the "worst". In lower-frequency but higher-coverage World Food Programme monitoring data, the seasonal peak varies just as widely, with prices failing to rise at all in a nontrivial share of seasons (Cardell and Michelson, 2022).

Existing interventions focused on price risk primarily target the arbitrage opportunity created by these seasonal price spikes. Improved storage (Basu and Wong, 2015; Delavallade and Godlonton, 2023; Aggarwal et al., 2018) and post-harvest credit have shown success by relaxing the liquidity constraints forcing "sell low, buy high" behavior (Burke et al., 2019; Mukherjee et al., 2024). However, these programs implicitly assume prices will rise. When they do not, returns to storage are negative, and recent evidence suggests such schemes can fail to improve welfare in flat-price seasons (Ligon and Silver, 2025). What households lack is not (only) access to the arbitrage but implicit insurance mechanisms against the price uncertainty they face.

This study tests demand for a direct price-hedging instrument, simple maize options contracts. A call contract gives a household the right, but not the obligation, to buy maize from a service provider at a pre-specified strike price during the lean season, capping its effective purchase price. A put contract gives the right to sell at a pre-specified floor price, guaranteeing a minimum sales price for households storing maize. Because the contracts are covered by physical grain stores held by the provider, they avoid the counterparty cash-flow problems that would make a traditional insurance instrument on prices infeasible.

In this study, our research questions are:

1. Is there positive, economically meaningful demand for maize option contracts as a form of price insurance among rural Malawian households, and how does revealed WTP compare to the actuarially fair time value of the contract (the premium)[1]?

[1]See Section 3.3 for details on how we calculate this.

2. How does demand vary with contract terms, most notably changes in the strike price and option length?
3. Is demand constrained by liquidity at the time of sale, as measured by sensitivity to deferred payment?
4. Is demand consistent with portfolio choice logic? That is, does demand correlate with a household's position in the maize market and their subjective expectations on prices?

Answers to these questions serve two purposes. First, household WTP for the described contracts is itself a revealed-preference measure of the welfare cost of seasonal price risk, complementing parametric estimates, such as those of Bellemare et al. (2013), who find that Ethiopian households would give up between 18 and 39 percent of their projected harvest value to eliminate price volatility in their diets and agricultural sales. Second, the demand estimates determine the viability of, and parameterize the design of, a subsequent randomized evaluation of the downstream effects of options coverage on consumption, storage, and marketing behavior.

2 Research Design

2.1 Setting and sample

The study takes place in Malemia Traditional Authority (TA) located in Zomba District, Southern Malawi, in August 2026 —about three months post-harvest, when many households still hold maize stocks and lean-season prices remain highly uncertain. The area is predominantly rural, with most residents engaged in agriculture.

Sampling proceeds in two stages from a complete village frame. We enumerate all 256 villages in the 15 Group Village Head (GVH) areas comprising the TA and assign each village to one of three strata according to the size of its GVH: stratum 1 pools the villages of the five GVHs with the most villages (150 villages), stratum 2 the five middle GVHs (63), and stratum 3 the five smallest (43). Within each stratum we draw villages by simple random sampling without replacement, with allocation approximately proportional to stratum size: 16, 7, and 5 villages respectively, for 28 villages in total. Additionally, 12 backup villages were selected following this procedure, which will be added in order if additional funding permits an increased sample size, or a village cannot be surveyed (e.g., if the chief refuses).

Within each sampled village, enumerators select 8 households by a random-walk protocol: each enumerator surveys an assigned number of households, skipping a predetermined number between each, walking outward from the village center in an assigned direction and turning right upon reaching the village edge. This yields 224 households, which we treat as a random sample from the village population.[2]

2.2 The product

Each contract is defined by a type (call or put), a strike price S per basin[3] of maize, and a coverage window. The default window is January–March 2027, the peak of the lean season. Strike prices take three values common to calls and puts: $S \in \{4{,}500;\ 6{,}000;\ 7{,}500\}$ MWK per basin. For reference, the average price per basin in Malawi at the time of our data collection was roughly 3,056 MWK, meaning that each call is "in the money" and each put is "out of the money", and the strike prices represent a 47 percent, 96 percent, and 146 percent increase relative to post-harvest prices, respectively.

Key to our design is the fact that calls are "covered" meaning that our implementing partner, PALM Consulting Limited, will store sufficient amounts of dried maize into the lean season to cover all contracts that are sold. This mitigates tail risk created by especially high spot prices that would create liquidity frictions for the program if maize to cover contracts was purchased on the spot market at the time of sale.

In the Becker–DeGroot–Marschak (BDM) elicitation exercise described below, households are randomly offered the opportunity to purchase a contract, conditional on their stated willingness-to-pay. For those participants who are chosen to purchase a contract, they may choose any quantity of guaranteed maize (either to buy or sell), up to 42 KG in 4.2 KG (a basin) increments. The choice to exercise the contract is at the holder's discretion within the exercise window stated on the contract they purchase (either January–March or November–March).

2.3 Elicitation procedure

As discussed in Section 1, the core purpose of this project is to measure demand for the contracts discussed above. To do so, our project uses a series of BDM elicitations, administered on tablets in SurveyCTO with a structured bisection script. The full sequence for each respondent is:

1. **Comprehension training and placebo BDM.** Enumerators explain the BDM game and run a practice round for a 1L bottle of cooking oil delivered in February 2027[4]

[2] Should resources allow, we may sample additional households from the pre-generated list of backup villages following the sampling procedure described above.

[3] In accordance with the unit measurements from the 2019 version of the Malawi Integrated Household Survey, we consider a basin of maize to be 4.2 KG.

[4] We conduct the exercise over a future delivery of cooking oil during the lean season so that we may

2. **Contract comprehension checks.** Before the real-stakes BDMs over the described contracts, respondents are asked a series of questions validating their understanding of (i) the value of a longer coverage window, (ii) the value of lower (higher) strike prices for calls (puts), and (iii) the premium-times-quantity payment structure. These comprehension questions once again create an opportunity for re-explanation.

3. **Six contract BDMs.** Our BDM elicitation asks respondents to value six contracts: three calls and three puts, one at each strike level, all with the January-March window. The order of the two modules (calls first vs. puts first) is randomized, and the order of the strike prices (ascending vs. descending) within each module is randomized within module.[5] Each BDM proceeds by iterative bisection over the support 200–4,000 MWK per basin in steps of 100, starting from a randomized initial price drawn uniformly from {1,800, 1,900, ..., 2,200}. Respondents who reject all prices are asked whether they would accept the contract at zero cost (distinguishing true zero valuation from negative valuation/distrust), and those who accept all prices are asked to state their exact WTP beyond 4,000 MWK. After the WTP is identified, respondents are asked to validate their WTP. During this validation, they are reminded of their final WTP from any prior elicitations. This reminder is provided to all respondents, regardless of their WTP responses, and serves to minimize rationality violations as a result of survey fatigue. As part of our high-frequency monitoring, we track how often a respondent reports a higher willingness to pay for a higher (lower) strike price for a call (put) than their prior elicitations. We also track how often respondents correct their WTP from the bisection mechanism. We will report both of these statistics as part of the description of our exercise alongside our main results.

4. **Window-extension elicitation.** For each contract, respondents state the additional amount they would be willing to pay to extend the option window of the contract into November and December, conditional on already holding the contract for the January–March window.

5. **Incentive-compatible resolution.** Once the respondent has completed the elicitation for each contract, the survey software chooses one of the contracts at random and com-

use households' willingness to pay in this placebo exercise as a proxy for their time discount rate over foodstuffs, with price support of 1,000 to 10,000 MWK in steps of 500. This placebo BDM includes several comprehension checks that provide enumerators with an opportunity to clarify the procedure prior to real-stakes elicitations.

[5]This randomization will later allow us to test for ordering effects. While a full randomization of the strike price offers would be preferred for this purpose, we opt to keep the strike prices either monotonically increasing or decreasing to aid in respondent comprehension and minimize rationality violations that result from confusion and survey fatigue.

pletes a random price draw. If the respondent's stated WTP for the chosen contract exceeds the randomly drawn price, the respondent is given the opportunity to purchase coverage at the drawn premium. They are given the opportunity to purchase up to 10 contracts (42 KG worth) and are allowed to use some or all of their survey incentive to purchase the contract.[6] The selection probabilities for the contract are *not* uniform; they follow a distribution that is calibrated around the actuarially fair value of the contract[7] This increases the logistical feasibility of the project by minimizing the odds of especially discounted contracts, increasing the probability that households will have the opportunity to purchase multiple units of coverage out of the incentive, and also maintaining incentive compatibility. The BDM mechanism remains truth-inducing under any draw distribution, provided the draws are independent of the respondent's stated WTP, which they are.

Following the choice to purchase the contract, a separate take-it-or-leave-it offer is made to the respondent to extend the coverage of their contract into the November-December window. This offer price is generated via a random draw from the set {1,500; 2,000; 2,500; 3,000} MWK and shown if the respondent had stated WTP above this amount.

Winning respondents sign a physical contract; a copy is retained by the household.

6. **Payment and deferred-payment margin.** Every respondent receives a 5,000 MWK participation reward. The *timing* of the reward is randomized at the individual respondent level with probability 0.5: delivery within one week of the survey, or delivery during the lean season (February 2027). Respondents may allocate any portion of the reward toward contract purchase, and pay any remainder in cash. The reward-timing randomization thus creates experimental variation in whether contract purchase draws on current cash versus a claim on future income.

2.4 Sources of experimental variation

For clarity, the randomized components are: (i) call-first vs. put-first module order; (ii) contract order within module; (iii) BDM starting price; (iv) identity of the binding contract; (v) the binding price draw; (vi) the window-extension price draw; and (vii) participation-reward timing. Components (iv)–(vi) make the elicitation incentive compatible and generate random variation in contract receipt conditional on WTP; component (vii) is the deferred-payment experiment; components (i)–(iii) are nuisance randomizations whose balance we

[6] As part of our data monitoring, we will collect and report the proportion of contract purchases that exceed the value of the survey incentive, and how many respondents choose to purchase contracts with cash on hand rather than their incentive.

[7] The calculation of the actuarially fair value is described in Section 3.3.

will verify and which we will use to test for order and anchoring effects.

2.5 Hypotheses

The hypotheses below are ordered as we take them up in Section 5, and each label corresponds to the specification that tests it.

Primary hypotheses:

P1. Positive demand and insurance value. Mean WTP is positive for each of the six contracts, and contract-specific demand, $D_j(p) = \Pr(W_{ij} \geq p)$, is bounded away from zero across the support of our BDM elicitations. A stronger test is whether the contracts carry insurance value, that is, whether WTP exceeds the actuarially fair premium π_j^{AF} computed from either of:

(a) The realized distribution of lean-season price outcomes in WFP monitoring data (22 seasons), as in our proposal document, updated with 2025/26 season data before analysis.

(b) The elicited subjective price distributions.

Households are risk averse, and as a result we expect WTP to lie weakly above the actuarially fair premium for at least some contracts. Any such gap is a revealed-preference measure of the welfare cost of seasonal price risk.

P2. Premium and strike-price gradients. Demand is decreasing in the premium and the implied elasticities are negative throughout the price support. Within household, WTP for calls is decreasing in the strike price and WTP for puts is increasing in the floor price. The strike gradient is the key internal-validity metric of this design, insomuch that it is a direct test of respondents' understanding of the contracts they are valuing.

Secondary hypotheses:

S1. Purchase margin. Conditional on stated WTP, the decision to purchase and the number of basins purchased carry the same contract-type and strike gradients as WTP itself. We also expect that the majority of households offered a contract at or below their stated WTP complete the purchase, and we report the share who renege.

S2. Deferred payment. WTP and purchase rates are higher among respondents whose participation reward is delivered during the lean season (a claim on future income) than among those paid within a week. A positive effect would indicate that lean-season liquidity, rather than valuation, constrains uptake.

S3. Coverage-window value. WTP to extend coverage from January–March to November–March is positive on average, and the share of households accepting the extension is decreasing in the randomly drawn extension price. Because the extension is offered on a take-it-or-leave-it basis rather than through a BDM, these measures are not incentive compatible in the same sense as our main elicitations, and we interpret them accordingly.

S4. Coherence with expected payouts. For each household–contract pair we compute the subjective expected payout, $\hat{R}_{ij}$ (defined in Section 3.3): the expected value of contract j's payout under household i's elicited price distribution. If valuations are coherent with beliefs, WTP is increasing in $\hat{R}_{ij}$ for all contracts.

S5. Heterogeneity by position in the maize market. Conditional on socioeconomic status, households with a stronger expected seller position in the lean season have higher WTP for puts, which insure the arbitrage return to storage, and households likelier to be lean-season net buyers have higher WTP for calls, which insure the cost of lean-season purchases. We further expect market position to amplify the expectations gradients in S4: the response of call WTP to $\hat{R}_{ij}$ is stronger among likelier net buyers, and the response of put WTP is stronger among likelier net sellers.

S6. Bunching at the incentive payment threshold. Conditional on WTP, the randomized premium generates exogenous variation in the amount of coverage households can purchase out of the incentive payments. We expect there to be some, but not full, bunching at the incentive payment. We note that this is consistent with both liquidity constraints and distrust in the project when incentives are paid (roughly) around the survey, as well as with rational discounting when incentives are paid in the lean season.

3 Data

3.1 Data collection

Data are collected by PALM Consulting Limited enumerators using SurveyCTO in August 2026. The survey instrument covers: subjective price expectations (bean-based five-bin elicitation over February 2027 prices, plus min/max and current spot price); the placebo and contract BDMs; contract purchase, payment, and signing; demographics; labor and income; harvest, storage, and crop sales; food security; and financial access and insurance familiarity.

3.2 Dependent Variables

The primary dependent outcome for this study, W_{ij}, is the maximum WTP (MWK/basin) of household i for contract j. For households who report that they are unwilling to pay any positive price for the contract, we set W_{ij} equal to zero, regardless of whether they state they are willing to enter into the contract for free. However, when estimating demand curves, we set demand as equal to zero at price zero for those households who indicate that they would not be willing to enter the contract, even for free.

Households who are offered the contract and choose not to purchase are included in our main analysis. However, to the extent that choosing not to purchase calls into question the WTP validity, we will separately report robustness to the exclusion of these households. We intend to report the number and proportion of respondents who renege on their stated WTP as such.

An additional dependent variable is Q_{ij}, the number of units (basins) of the contract household i purchases of contract j, conditional on it being offered to them. Since we observe this for at most one contract per household, analysis of it is likely to be underpowered and we therefore view it as exploratory. Households are also asked how many units they would purchase if liquidity constraints or the maximum of 10 units imposed by the project did not bind. Since this is an unincentivized hypothetical, we also view it as exploratory.

3.3 Independent Variables

To test the hypotheses discussed in Section 2.5, we construct several independent variables.

- Subjective expectations: mean $\hat{\mu}_i$ and standard deviation $\hat{\sigma}_i$ of the February 2027 price from the five-bin histogram using the midpoint for each bin and bounds for top- and bottom-coded bins.
- Market-position variables (described in detail in Section 3.4).
- Incentive timing: A dummy variable that takes the value one if a respondent is randomly assigned to receive their survey incentive during the lean season (as opposed to within a week from the survey).
- Actuarially fair premia: Defined as a premium where, in expectation, both the respondent and the service provider break even, save load costs such as transportation and storage. This is calculated via a Monte Carlo simulation that creates a data-generating process (DGP) of lean season price realizations (defined as percent increases from May

1st prices to account for year-over-year price inflation) from the World Food Programme's price monitoring data and calculates the respondent and service provider's net position under 1,000 draws of lean season prices from the DGP for each potential strike price. For each contract and strike price, the actuarially fair price is defined as the premium where, on average across the 1,000 draws, the net position of both the respondent and service provider is zero. We note that this is an approximate benchmark that implicitly assumes the gradient of prices is i.i.d. across years. Ideally, our calculation would take into account additional information—such as the recently elected government's campaign promises to keep prices low through imports and information on the 2026 harvest amid high fertilizer prices and poor rains. As an alternative, we will compute this premium with respect to the elicited distribution of expected lean season prices rather than the historical distribution, which captures the extent to which households have updated based on such information. In a paper, we may also explore additional assumptions about the distribution of potential price increases.

- Subjective expected payouts: for each household i and contract j, we define $\hat{R}_{ij} \equiv \hat{E}_i[(p_1 - \bar{p}_j)^+]$ for calls and $\hat{R}_{ij} \equiv \hat{E}_i[(\bar{p}_j - p_1)^+]$ for puts, where the expectation is taken over the household's elicited five-bin price histogram. As with subjective expectations above, we use the midpoint for each bin and bounds for top- and bottom-coded bins.
- Comprehension quality: pass/fail indicators on first attempt for BDM and contract comprehension checks.

3.4 Heterogeneity variables

We prespecify two families of heterogeneity dimensions, both measured in the same survey (before any contract outcomes are realized):

(a) Last year's realized position in the maize market.

- *Stock-out*: whether the household ran out of stored maize last season, and the month it ran out, converted to months-since-harvest, and the number of bags they purchased after stock-out.
- *Seller status*: whether the household sold maize in the past two years, and the number of bags they stored for sale later in the harvest.

(b) Expected position this year.

- Whether the household expects to sell maize between now and the next harvest.
- The month the household expects to run out of stored maize this year, converted to months-since-harvest.
- Stock-adequacy ratio: defined as the current stock of maize relative to household size (measured in adult equivalents), as a proxy for the household's expected lean-season position.

To adjust for multiple hypothesis testing, we will collapse these indicators into a single summary weighted index (using swindex in Stata). We will also report heterogeneity across individual components accompanied by FDR-adjusted Q-values.

Our hypothesis is that households with a lower net position during the lean season (i.e. more likely to be buyers) will place greater weight on calls, relative to puts, and vice versa for those with a stronger lean-season position.[8]

3.5 Data quality and anticipated challenges

Any BDM-based WTP may be confounded by poor comprehension or anchoring and order effects. To cope with these challenges, we have built a series of mitigations into our instrument. To ensure comprehension, participants first undergo a placebo BDM for 1L of oil, followed by comprehension questions with built-in remediation for both the BDM mechanism itself and the characteristics of the offered contracts. To test for anchoring effects, within each elicitation, the first price offered is randomized within a sub-interval of the price support. To test for ordering effects, we randomize whether the strike price offers are ascending or descending within module (i.e. they can be ascending for calls and descending for puts, and vice versa). We also randomize whether respondents are offered puts or calls first.

We will report results from robustness checks that exclude households who fail the comprehension test for either the BDM or the contracts. We will also report regression results that test the effect of receiving puts first, having an ascending strike price gradient, and the initial price offer on respondents' final willingness to pay.

3.6 Inference

We primarily target estimands (means, demand curves and treatment effects from secondary randomizations) from the population of Malemia TA, which was selected for this study

[8]While individual WTP estimates are expected to be confounded by socio-economic status, the ratio of WTP between calls and puts should be internally consistent. As such, our heterogeneity analysis will explore this ratio as a secondary outcome.

because of its prior experience with crop insurance and proximity to PALM's offices in Zomba. We therefore use design-based inference methods with finite population corrections based on the two-stage sampling procedure. Since we are concerned about the reliability of chiefs' reports of total village population, we only weight by this in a secondary specification. If one prefers to nonetheless think of villages in Malemia as randomly drawn from across Malawi, we also compute cluster-robust standard errors at the village level using the wild bootstrap. As the reward-timing effect is randomized at the household level, we report both design based and heteroskedasticity-robust standard errors.

4 Adaptive design: pre-committed adjustment rules

Given that this is the first elicitation of demand for these products in this setting, the design parameters (strike levels, BDM price support, reward size) are based on simulations and limited piloting of the instrument. As such, there may be cause to adjust these parameters throughout the course of our data collection (for instance if we find that there is extremely limited demand for a specific strike price). As such, we intend to pre-commit to the following adaptation protocol, in the spirit of a sample-size or design interim review, rather than making ad hoc mid-stream changes:

A1. Review points. We will conduct a design review after the first 50 households are surveyed and will conduct at most one additional review past that point, and not before 125 households have been surveyed. No design parameters will be changed except during these reviews.

A2. What may change, and triggers. At a review, we may:

- *Shift strike prices* if estimates indicate that less than 10 percent of respondents have a positive willingness to pay for the call option with the highest strike price, or more than 10 percent of respondents are willing to pay the upper bound of the support (4,000 MWK) for the call with the lowest strike price, we may narrow the interval of the strike prices offered. The converse rule applies to puts.
- *Contract documentation and signing procedure* If more than 10 percent of households who are offered the contract refuse to eventually purchase the contract, it may signal that there is low trust in the product and our ability to satisfy the contracts. In these cases, we will explore alterations to the contract products themselves, such as making them simpler, as well as exploring signing options where the contracts are only signed in the presence of the village head.

- *Payment procedure* If we find that less than 10 percent of households who are offered the contract make purchases beyond their survey incentive, it may signal that there is demand for the product but liquidity constraints prevent respondents from meeting their preferences. If this is the case, we will consider allowing for a grace period of 24 hours to one week for respondents to collect the funds needed to cover the purchase of the contract.
- *Price draw* Part of the purpose of the project is to observe the mechanics underlying the offered contracts, and as such there is a need for a suitable density of executed contracts. Upon review, we may increase the density of the probability function underlying the price draw to place greater weight on lower contract premiums. This will ensure that, on average, more contract offers are made, but does not affect our interpretation of WTP responses given that respondents do not observe the underlying price draw CDF.
- *Enrollment criteria* The contracts we offer are written on maize, and we primarily intend to enroll farmers who grow it. However, we have not imposed maize production as a part of our selection criteria, and the random-walk protocol described in Section 2 does not condition on it. As such, we will monitor the composition of enrolled participants, and if more than 10 percent of them are non-maize growers, we may impose an additional enrollment criterion that farmers grow maize.

A3. What may never change. The elicitation mechanism (BDM), the definitions of our main outcomes in Section 3, and the pre-specified estimations.

A4. Documentation. We pre-commit to log and report every change to the design with the date, trigger, rule, and description of the change.

5 Analysis

5.1 Primary specifications

P1 (Demand). Our primary purpose is to test the demand for the offered contracts. As such, we intend to report a set of statistics regarding the premium and contract-specific demand, $D_j(p) = Pr(W_{i,j} \geq p)$. Specifically, for all p within the support of our BDM elicitations, we will present summary statistics for $D_j(p)$ (the average demand for contract j at price p), report results from the t-test that demand is equal to zero $D_j(p) = 0$, and the results for a test of equality across strike prices ($D_j(p) = D_{j'}(p)$ where $j \neq j'$) within contract type (i.e. across calls or puts).

In addition to demand curves, we will report overall WTP. We will report the mean $W_{i,j}$ for each contract type alongside the p-values for the hypothesis tests $W_{i,j} = 0$ and $W_{i,j} > \pi_j^{AF}$ where π_j^{AF} is the actuarially fair premium calculated through Monte Carlo simulation from the WFP lean-season price distribution (updated through the most recent season prior to analysis), with robustness to the WTP from the elicited subjective lean-season price distribution, both described in Section 3.3.

P2 (Elasticities with respect to premia and strike price). In addition to providing an incentive-compatible measure of WTP, the BDM framework also allows for the direct calculation of demand elasticities with respect to contract premia.[9] We will report the point estimates and standard errors[10] for these elasticities at the 10th, 25th, 50th, 75th, and 90th percentiles of the price support of our BDM elicitation.

Beyond premium, we are also interested in the gradient in demand across contract types. With six observations per household, we can test how demand responds to different strike prices through the estimation:

$$W_{ij} = \alpha_i + \beta_1 \,\mathrm{Mid}_j + \beta_2 \,\mathrm{High}_j + \gamma \,\mathrm{Put}_j + \delta_1 \,\mathrm{Mid}_j \times \mathrm{Put}_j + \delta_2 \,\mathrm{High}_j \times \mathrm{Put}_j + \varepsilon_{ij}, \tag{1}$$

where α_i are household fixed effects, Mid/High indicate the 6,000 and 7,500 MWK strikes, and Put indicates put contracts. Standard errors are clustered at the household level. If households are (on average) rational, we expect $\beta_1, \beta_2 < 0$ (calls) and $\beta_1 + \delta_1, \beta_2 + \delta_2 > 0$ (puts), with monotonicity ($\beta_2 < \beta_1$, etc.).

5.2 Secondary specifications

S1 (Purchase Elasticities). Since contract offers are random, conditional on WTP, we can also run the specification:

$$Q_{ij} = \alpha + \beta_1 \,\mathrm{Mid}_j + \beta_2 \,\mathrm{High}_j + \gamma \,\mathrm{Put}_j + \delta_1 \,\mathrm{Mid}_j \times \mathrm{Put}_j + \delta_2 \,\mathrm{High}_j \times \mathrm{Put}_j + \phi W_{i,j} + \varepsilon_{ij}, \tag{2}$$

where $Q_{i,j}$ is a set of indicators related to the sale of the contract, including a purchase indicator, and the (log) quantity of purchases. Here, conditioning on $W_{i,j}$ controls for the fact that the conditional expectation of receiving an offer is a function of households' willingness to pay.

[9] Calculated as $\frac{\frac{D_j(p) - D_j(p')}{D_j(p)}}{\frac{p - p'}{p}}$

[10] Standard errors for the elasticities will be bootstrapped.

S2 (deferred payment). We can leverage the household-level payment randomization to study how the timing of part of the payment affects demand (c.f. Casaburi and Willis, 2018) using the estimation:

$$W_{ij} = \lambda_j + \theta \, \text{LateReward}_i + u_{ij}, \tag{3}$$

with contract fixed effects λ_j, and clustering at village level following the sampling procedure. As in test (P2), we can once again adjust the specification for a set of purchase variables by conditioning on households' willingness to pay.

S3 (window extension). Since we provide households with a chance to refuse the extension (and keep the January-March contract they agreed to) these stated demands do not have the same incentive-compatible nature as measurements from our BDM elicitations. With that caveat in mind, we report the average WTP for extension for each contract and the number of households who purchase the extension for each randomly selected price in the uniform price draw, reported by contract type.

S4 (subjective expected payout coherence). If households' valuations are coherent with their beliefs, WTP should be increasing in the expected payout of each contract under the household's own subjective price distribution. To test this hypothesis, we use the subjective expected payout of each contract, described in Section 3.3, within the estimation:

$$W_{ij} = \alpha_i + \lambda_j + \beta \hat{R}_{ij} + \varepsilon_{ij} \tag{4}$$

with standard errors clustered at the village level following Section 3.6. We expect $\beta > 0$ for all contracts.

Additionally, if households are risk averse and view the product as a price insurance mechanism, demand for both contract types should be higher among those with more dispersed price expectations. As such, as a complement to Equation 4, we allow $\hat{\mu}_i$ and $\hat{\sigma}_i$ from our subjective price expectation exercise to enter directly into the estimation:

$$W_{ij} = \alpha + \beta_1 \hat{\mu}_i + \beta_2 \hat{\sigma}_i + \varepsilon_{ij}, \tag{5}$$

While we expect this test to be underpowered relative to Equation 4 because we cannot leverage within-household variation, directionally, we expect β_1 to be positive for calls and negative for puts, while β_2 should be positive for all contracts.

We also compute the number of households purchasing strictly dominated contracts based on their subjective price elicitations. This would include a household who is willing to buy a call (put) at a strike price that is greater (less) than the maximum (minimum) price they believe can occur.[11]

S5 (maize position heterogeneity). Finally, conditional on socio-economic status, we expect households with a stronger seller-position during the lean season to have higher willingness to pay for puts, as this acts as an insurance instrument on arbitrage profits from storage into the lean season. Conversely, those who are likely to be net buyers in the lean season face higher risks to their diets from higher price realizations and, as a result, should have a higher willingness to pay for calls. We test this hypothesis with the specification:

$$W_{ij} = \alpha + \beta_1 M_i + X_i\gamma + \varepsilon_{ij} \tag{6}$$

Where M_i is the summary-weighted index of our maize-position heterogeneity variables, and X_i is a vector of controls we use to proxy for households' socioeconomic status. These include a food security index generated from two questions selected from the FIES and included in our survey, household income over the previous 30 days, households' perceived ability to cover unexpected expenses of 50K MWK and 100K MWK, and households' perceived ability to obtain a loan. We expect $\beta_1 > 0$ for puts and $\beta_1 < 0$ for calls.

This index also allows us to conduct an additional test for if households view the contracts as a hedging instrument, by interacting ones expected maize market position with the expected payout of each contract and the contract type:

$$W_{ij} = \alpha_i + \lambda_j + \beta\hat{R}_{i,j} + \delta_1\left(\hat{R}_{ij} \times M_i\right) + \delta_2\left(\hat{R}_{ij} \times M_i \times \text{Put}_j\right) + \kappa\left(M_i \times \text{Put}_j\right) + \left(\hat{R}_{ij} \times X_i\right)\gamma + \varepsilon_{ij} \tag{7}$$

Where M_i, Put_j, and X_i are subsumed by the household and contract fixed effects. If households indeed primarily view these contracts as hedging instruments, we would expect that per unit of expected return, calls are more valuable to likely net buyers ($\delta_1 < 0$) and puts are more valuable to likely net sellers ($\delta_1 + \delta_2 > 0$)

S6. (Bunching at the incentive payment) The incentive payments jointly address the potential for liquidity constraints and trust confounds. The randomized premia induce variation in how many units of coverage a household offered a contract would be able to buy out of the incentive. For those who can purchase $\bar{q}_{ij} \in [2, 9]$ units of the selected contract out

[11] We also confirm with households whether they believe the maximum strike price plus premium they agreed to for calls and minimum strike price minus premium they agreed to for puts is in the range of possible prices after they make their choices.

of the incentive[12] we will test for excess mass on $Q_{ij} = \bar{q}_{ij}$ relative to $\bar{q}_{ij} - 1$ and $\bar{q}_{ij} + 1$. Under the joint null of no liquidity constraints and perfect trust, the amount of coverage that can be paid of the incentive should not predict total coverage demanded—at least when incentives are not deferred to the lean season. For households assigned the deferred incentive, bunching can also occur if future payments are sufficiently discounted, which we discuss in Section 6. We will therefore show a histogram of number of units purchased relative to the maximum payable out of the incentive and tests for excess mass disaggregated by incentive-timing arm.

6 Welfare Implications

Here, we pre-specify the moments in a farm-household's Euler equation that our elicitations can identify in principle. Let $m \equiv \beta\, u'(c_1)/u'(c_0)$ denote the household's stochastic discount factor between harvest and the lean season and let $x^+ \equiv \max\{x, 0\}$. For a marginal basin of coverage, an incentive-compatible WTP elicited at harvest satisfies $W_j^C = \mathbb{E}[m(p_1 - \bar{p}_j)^+]$ for a call and $W_j^P = \mathbb{E}[m(\bar{p}_j - p_1)^+]$, where p_1 is the stochastic lean-season price, $\bar{p}_j$ is the strike price of contract j and F is the (subjective) CDF of p_1. The design therefore measures, in principle: (i) the seasonal discount factor $\mathbb{E}[m]$, from the cooking-oil BDM (a claim on a fixed lean-season quantity of a good with a stable real price); (ii) a discretized approximation to the subjective price distribution F, from the binned expectations elicitation; and (iii) the option moments $\mathbb{E}[m(p_1 - \bar{p}_j)^+]$ and $\mathbb{E}[m(\bar{p}_j - p_1)^+]$ at each strike $\bar{p}_j$. The residual—the covariance of marginal utility with the payout—prices the welfare loss from marginal exposure to the price risk covered by each contract. The key moments are labeled below by how they are identified.

$$\underbrace{W_j^C}_{\text{observed WTP}} = \underbrace{\mathbb{E}[m]}_{\text{cooking oil}} \cdot \underbrace{(1 - F(\bar{p}_j)) \cdot \mathbb{E}[(p_1 - \bar{p}_j) \mid p_1 \geq \bar{p}_j]}_{\text{subjective price elicitation}} + \underbrace{\operatorname{cov}\big(m,\, (p_1 - \bar{p}_j)^+\big)}_{\text{residual: hedging value}} \tag{8}$$

$$\underbrace{W_j^P}_{\text{observed WTP}} = \underbrace{\mathbb{E}[m]}_{\text{cooking oil}} \cdot \underbrace{F(\bar{p}_j) \cdot \mathbb{E}[(\bar{p}_j - p_1) \mid p_1 \leq \bar{p}_j]}_{\text{subjective price elicitation}} + \underbrace{\operatorname{cov}\big(m,\, (\bar{p}_j - p_1)^+\big)}_{\text{residual: hedging value}} \tag{9}$$

Another implication of the model is that the difference in WTP for a call and a put at a common strike price should be linear in the strike price with a slope of $-\mathbb{E}[m]$.[13] This

[12] $> 95\%$ of drawn premia are 2,500 MWK or below, allowing the purchase of at least two units, while all contracts but the highest call and lowest put—which are each selected with 5% probability—have roughly a 99% chance of a premium above 500 MWK, which would not allow the household to purchase the maximum of 10 units out of the incentive alone.

[13] This is the shadow-price analogue of the call-put parity result from Stoll (1969), which follows from the payoff identity $(p_1 - \bar{p}_j)^+ - (\bar{p}_j - p_1)^+ = p_1 - \bar{p}_j$: the difference between call and put WTP at a common

is a test of internal consistency that is robust to beliefs and risk preferences, and the slope provides an alternative, real-stakes identification of $\mathbb{E}[m]$, complementing the cooking-oil measure.

We recognize that with 224 households, a discount-factor measurement taken during the practice round, and instruments fielded for the first time in this setting, these moments may be noisy or unusable. We therefore treat this mapping as background structure rather than an analysis plan: we do not commit to estimating these objects, to any particular estimation strategy for them, or to including such analysis in a resulting draft, and we reserve discretion over whether and how to use this structure. Any analysis based on it will be labeled exploratory. Its principal role is to inform the pre-analysis plan of the follow-on RCT, which will be registered and pre-specified separately.

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strike satisfies $W_j^C - W_j^P = \mathbb{E}[mp_1] - \mathbb{E}[m] \cdot \bar{p}_j$, and is therefore linear in the strike with slope $-\mathbb{E}[m]$.

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