Expecting Too Much, Foreseeing Too Little? Behavioral Explanations for the Sell Low-Buy High Puzzle in Smallholder Market Participation

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Results from first midline

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Abstract

It is often observed that smallholder farmers sell most of their marketable surplus immediately after the harvest when seasonal price movement reach their lowest point, instead of waiting just a few more months until prices recover. Most explanations for this apparently sub-optimal behavior focus on economic or infrastructural issue, such as credit constraints or lack of storage facilities. In this study, we zoom in on two potential behavioral explanations. One explanation is situated at the household expenditure side, and assumes that households face challenges in accurately predicting future expenditures, systematically underestimating future needs. A second potential explanation is situated at the household income side. Here the assumption is that farmers suffer self-control problems and are not sophisticated about this leading them to sell too early and/or at lower prices. To test these hypotheses, we conduct two planning based interventions among a sample of Malawian smallholder farmers: a detailed expense budget and a sales plan with explicit commitment to timing of sales, quantities and prices. At the first midline, we find that households that were exposed to the interventions have higher stocks at the time of the midline survey. There are also indications that households that were exposed to the interventions are less likely to turn to the market to buy back some of the commodities they sold.

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1 Introduction

It is often observed that smallholder farmers sell most of their marketable surplus or cash crops immediately after the harvest to itinerant traders at the farm gate. Selling immediately after the harvest is not optimal: Thin and poorly integrated markets often mean that immediately post harvest prices in excess supply areas drop to their seasonal low. In addition to high supply immediately post harvest, agricultural commodities are often not yet in optimal condition. For instance, in the case of maize, fresh grains are generally not dry enough, requiring further processing and leading to increased risk of rot by the trader. Often, this is used by buyers as an additional reason to further drive down the price paid to the farmer.

Over time, prices gradually recover, reaching their seasonal high just before the next harvest. At this time, many farmers have run out of stock, and need to turn to the market to buy back maize at prices that are often a multiple of what they received, a phenomenon known as the "sell low-buy high" puzzle (Stephens and Barrett, 2011; Burke, Bergquist, and Miguel, 2018). Van Campenhout, Lecoutere, and D'Exelle (2015) further show how farmers loose out twice, as transaction costs are passed on by traders to farmers when traders buy commodities from farmers in rural areas to aggregate in consumer centers, but farmers also incur transaction costs when they buy back (often from the same traders in towns, or large warehouses in trading centers).

The literature suggest many possible reasons why farmers choose the sell early at low prices instead of waiting a few months until prices recover. Farmers may simply not have the space and infrastructure available to safely store large quantities of maize for extended periods of time (Omotilewa et al., 2018). They may be in urgent need of cash after the lean season (Burke, Bergquist, and Miguel, 2018; Dillon, 2021). Price movements may be unpredictable and farmers may be too risk averse to engage in intertemporal arbitrage (Cardell and Michelson, 2020). It may be that traders only visit villages immediately after harvest, and farmers do not have the means to transport maize to markets themselves. Furthermore, issues related to social taxation may mean farmers convert maize to cash, which is easier to hide from friends and family (Jakiela and Ozier, 2015).

Most of the explanations above focus on neoclassical constraints to farmers' exploiting inter-temporal arbitrate. In this study, we zoom in on two potential behavioral explanations why farmers seemingly sell at sub-optimal timing. One potential explanation is situated at the household expenditure side, and assumes that households face challenges in accurately predicting future expenditures. Such budget neglect leads farmer to sell more early on and save too little for later in the year (Augenblick et al., 2021). A second potential explanation is situates at the household income side. Here the assumption is that farmers

face self-control issues and are unsophisticated about this (Duflo, Kremer, and Robinson, 2011). As a result, farmers end up selling at lower prices and earlier in the year then they would if they would be able to better commit (Ashraf, Karlan, and Yin, 2006).

The above hypotheses are tested with a field experiment among smallholder farmers in Malawi. These farmers produce (a mix of) maize, groundnuts and soybean from which at least part is destined for the market. Our experiment takes the form of a simple parallel design with two treatment arms and one control group. A first treatment arm tests for the role of budget neglect in explaining the sell low-buy high paradox: Farmers that are randomly assigned to the first treatment arm are taken through a detailed budgeting exercise immediately after harvest. In particular, in this intervention a trained enumerator sits with the household head and fills in a budget matrix of projected expenses for each month in the coming year. The second treatment arm tests the importance of failure to commit. Farmers that are randomly allocated to the second treatment arm receive a sales planning intervention. Here, a trained enumerator sits with the household head and plans how much they plan to sell of which crop in which month during in the coming year. For each planned sale, the household head is also asked to commit to a minimum price is that they expect. Impact of the interventions on a variety of outcomes is compared against outcomes of a control group that did not get any intervention.

This document has been compiled immediately after the first midline survey was collected (via telephone). It is based on the pre-analysis plan and the mock report, and compares outcomes about 6 months post intervention of households in the treatment groups to outcomes of households in the control group. We find that, consistent with the theory, households in treatment groups remain with larges stocks of the maize and groundnuts. We also find that households in the treatment group were less likely to have bought soybean. In general, effects are stronger for the sales plan intervention than for the budgeting intervention. Somewhat surprisingly, we also find that households that received the sales plan intervention were more likely have sold groundnut , and sold larger quantities, in the first few months after the intervention.

In the next section, we provide a selective overview of related studies. We then outline the main research hypothesis we want to test, and describe the interventions we will use to do so. We then turn to the data with subsections that present descriptives for the study population and balance between treatment and control groups. We then turn to the midline data and report attrition and impact on primary and secondary outcomes. A last section concludes.

2 Related Research

Why do farmers "sell low and buy high"? One of the most obvious neo-classical explanations is related to credit constraints. Using observational data, Stephens and Barrett (2011) find that to meet consumption needs later in the year, many farmers end up buying back grain from the market a few months after selling it,

in effect using the maize market as a high-interest lender of last resort. Burke, Bergquist, and Miguel (2018) show that in a field experiment in Kenya, credit market imperfections limit farmers' abilities to move grain intertemporally. Providing timely access to credit allows farmers to buy at lower prices and sell at higher prices, increasing farm revenues and generating a return on investment of almost 30%. Dillon (2021) uses the fact that in Malawi, primary school began 3 months earlier in 2010 than in 2009, and notes that this prompted households with children to sell maize when prices are particularly low. To identify the impacts of liquidity constraints during the lean season, Fink, Jack, and Masiye (2020) offered subsidized loans in randomly selected villages in rural Zambia. They find that relaxing liquidity constraints not only changed marketing behavior, but also increased labor allocated to agricultural production (as opposed to day laboring as a coping strategy) and conclude that liquidity constraints thus contribute to inequality in rural economies in the longer run as well. While credit constraints thus seems to be an important reason why farmers sell immediately post harvest at low prices, we feel this is not the entire story. If farmers need urgent cash, it would make more sense to only sell part of the harvest to cover most urgent expenses, or to sell commodities that are less affected by price seasonality, like small livestock. However, farmers often seem to sell all of their marketable surplus immediately post harvest in a single transaction.

Risk averse farmers may also fail to delay sales if there is considerable uncertainty about the price in the future. A recent article by Cardell and Michelson (2020) argues that the "sell low buy high" puzzle is not a puzzle at all. Using 20 years of data from 787 markets in 26 countries, they argue that in many cases the price increase seems insufficient and too uncertain for farmers to engage in inter-temporal arbitrage (Cardell and Michelson, 2020). However, their analysis use prices obtained from market centers, which may be a poor proxy for the farm gate prices that farmers face: prices in main markets are generally much better integrated in the wider national, regional and even global economy, and so will be less prone to the extreme spikes and slumps that smallholder farmers in more remote areas experience.

A third reason may be that farmers have nowhere to safely store crops, so they just sell. This could be a lack of space, as the average smallholder often harvest 20-40 bags of 50kg of maize. But there are also risks related to pests and diseases affecting the stored maize. If lack of safe storage is the main reason why farmers do not engage in intertemporal arbitrage, then providing storage technology should delay sales. Omotilewa et al. (2018) indeed find that households that received PICS bags, a type of hermetically sealed bag of two layers of polyethylene liners and a third layer made from woven polypropylene, stored maize for a longer period and reported a substantial drop in storage losses. Again, we feel storage is indeed part of the reason, but it does not explain everything. For instance, this explanation is at odds with the fact that Agricultural Commodities Exchange (ACE) in Malawi consistently fails to fill its warehouses.

Another reason may be related to social taxation. If a farmer has a lot of maize stored in his house, this is visible for family and neighbors, and it will

be very hard to deny if neighbors come and ask for help during the hunger season. Therefore, farmers may choose to convert their harvest to money, which is easier to hide, even though this comes at a cost. Social taxation has been found important in a similar marketing decisions where household seem to forgo the benefits of buying in bulk (Dillon, De Weerdt, and O'Donoghue, 2020).

Related research on the more behavioral and psychological front that helps explain the puzzle is ongoing. Augenblick et al. (2021) study recurrent seasonal hunger in Zambia, which could be a direct consequence of suboptimal marketing behaviour, and conjecture that individuals tend to overestimate their available resources and consequently under-save. They test this hypothesis through an intervention that induces individuals to think through their budget set and formulate a spending plan. They find that treated households enter the hunger season with one additional month of savings, leading to a smoother spending profile over the year.

Our research is also related to an established literature on lack of self-control in cases where individuals have to make complex intertemporal decisions involving uncertain future events. If farmers are impatient and unsophisticated about this, nudges may be effective in reducing discretionary spending in increase investment in the future (Duflo, Kremer, and Robinson, 2011). Dupas and Robinson (2013) find that devices which simply help individuals harness the power of mental accounting helps them to save more.

3   Behavioural constraints to intertemporal arbitrage: Hypotheses and Interventions

The first potential behavioral explanation for the sell low buy high puzzle is situated at the household expenditure side, and assumes that households face challenges in accurately predicting future expenditures. In particular, we assume that farmers systematically underestimate how much money they need in the future and as a result sell too much immediately after the harvest. For example, immediately after harvest, they may budget for fresh seed from the agro-input dealer and for fertilizer, but they may forget that they also need pesticides and insecticides. Furthermore, farmers may underestimate the likelihood of, or simply forget to account for, unexpected events such illness within the family.

There are various reasons why individuals may suffer from this kind of budget neglect. In general, predicting the full set of expenditures under all possible states of the world is likely to be beyond the cognitive capacity of human beings (Augenblick et al., 2021). It is also related to the planning fallacy, where individuals typically underestimate the time it takes to complete a task, despite extensive experience with failure to complete the same task in a similar time frame in the past (Buehler, Griffin, and Peetz, 2010). Part of it may also be related to optimism bias if farmers neglect or underestimate the risk that adverse effects will happen to them (Sharot, 2011).

To test the first hypothesis, we designed an intervention that takes the farmer

through a detailed budgeting exercise. In particular, the main decision maker within the household was provided with a template that needed to be filled in as detailed as possible. Pre-populated expenditure categories included education expenditures (school fees, uniforms,...), agricultural investment expenditures (seed, fertilizer,...), investment expenditure in non-agricultural businesses (retail shop inventories,...), health and medical expenses (medicines, preventive doctor visit,...), household recurrent expenditure (food, utilities,...), household equipment and maintenance (furniture, renovation,...), and other expenditures (loan repayment, ceremonies,...). For each of these expenditure item lines, farmers were then asked to provide an estimate of the total cost for each month between May 2022 and April 2023 and write it down in the appropriate cell of the expenditure matrix. Farmers were also encouraged to provide their top 3 unexpected expenditures likely to occur between May 2022 and April 2023. We then calculate totals per month and also a grand total for the entire year. This first intervention will be referred to as treatment one (T1).

The second hypothesis is also related to cognitive limitations when planning, but this time at the income side of the farm household. While farmers may initially have a good idea of when to sell and at what price, various factor may lead them to revise the plans and sell sooner and at lower prices. These include unexpected events but also social taxation (Jakiela and Ozier, 2015) Furthermore, farmers may be influenced by various decision heuristics (such as seeing their neighbor sell their crop) that are at odds with their plans and again revise to sell earlier or at lower prices.

To test if the sell low-buy high puzzle is predominantly cause by a failure to commit, we develop, together with the farmer, a detailed sales plan for the year which is assumed to function as a commitment device closely modeled in the idea of mental accounting. Again using a template, we start by asking the farmer about the expected marketable surplus for maize, groundnuts and soybean. We then ask for each month between May 2022 and April 2023 how much the farmer is planning to sell for each of the crops, and what the minimum price and point in time should be before they sell. Also for the sales plan, we calculate totals per month and also a grand total for the entire year. This second intervention will be referred to as treatment two (T2).

We did not merely ask farmers to create these plans, but also encouraged them to hang them in a central place in the house or store them in a convenient location. We also encouraged them to update them regularly. Furthermore, to increase the likelihood that farmers use the plan, we also refer to the plan during midline surveys, and reiterate the importance of using these plans.

4   Data collection

Baseline data collection took place around the end of May and beginning of June 2022. Using tablet computers and Open Data Kit software, 31 enumerators interviewed 3534 farmers that were sampled from four districts in the Central and Northern Regions of Malawi (Kasungu, Ntchisi, Dowa and Mchinji). The
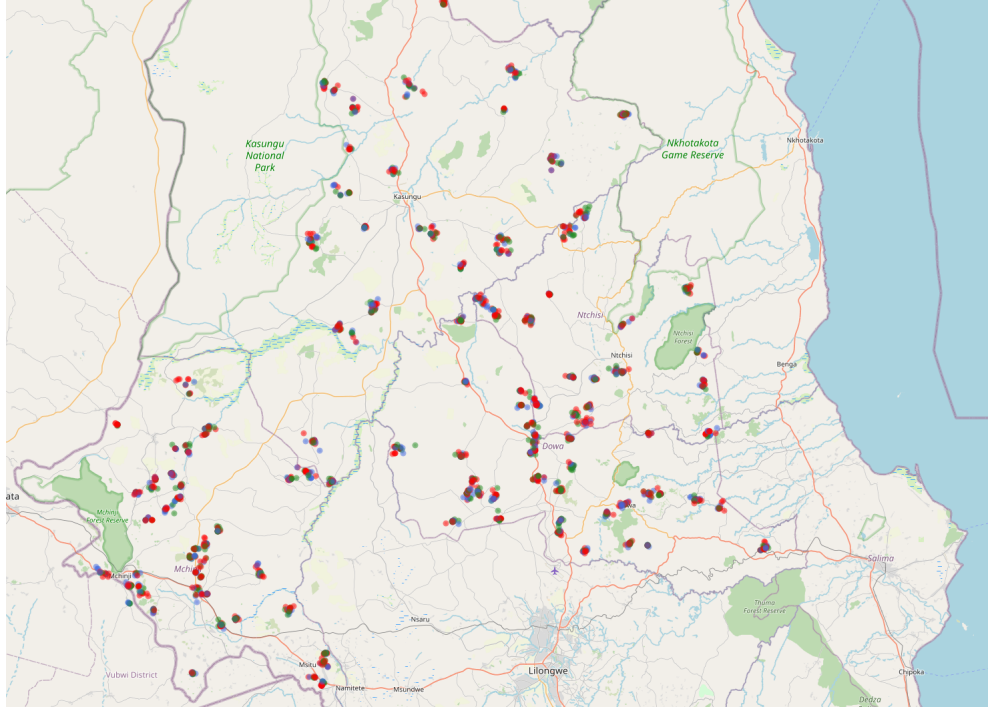
Figure 1: map of study area with sampled villages

study areas are characterized by rain-fed agriculture with a single agricultural season.

We selected farmers that produce maize, groundnuts and/or soybean. Maize is planted early in the year and harvest starts usually starts in April and proceeds through May. Soybean is harvested somewhat earlier, groundnuts somewhat later. Soybean and groundnuts can be sold pretty much immediately after the harvest; maize needs to be dried first.

To get a nationally representative sampling frame of the smallholder farmer population in Malawi, we rely on the list created by the Ministry of Agriculture for their Agricultural Input Programme (AIP). The AIP targets smallholder farmers in the villages who mostly registered with the village chiefs. We used a two-stage sampling procedure where we first sampled villages with the likelihood of a village being selected proportionate to the number of people that live in this village (such that larger villages are more likely to end up in the sample). We then randomly sampled 31 households in each of the sampled villages. Figure 1 gives a sense of coverage and dispersion of the interviewed households.

The focus of the study is on market participation and so the targeted study population consists of farmers that are likely to engage with markets. As such, we included qualifier questions in our survey, where we asked farmers if they were planning to sell maize, soybean or groundnuts during the 2022 season.

Restricting our study population to a particular sub-population has implications for the interpretation of the results. For instance, we will see later that we find relatively high proportions of households reporting to sell to the market. As such, the particular nature of the study population, semi-subsistence smallholder farmers, needs to be kept in mind when interpreting results, as they may be different from for example predominantly self-sufficient farmers.

Midline data was collected by phone over the course of one month (September 2022).

4.1 Farmer characteristics

Table 1 presents a number of summary statistics of sampled households and their heads at baseline. Eighty percent of households are headed by men. The average household is headed by a 43 year old with six years of schooling (primary level). The typical household has five members, living in houses of three rooms. Four in every 10 households have their main houses roofed with corrugated iron sheets (as opposed to thatch roofing). We find that the average distance of the households to the nearest all weather road and nearest market is 1 and 4 km respectively.

We also collected information on access to transport facilities or assets (either through ownership or hire). Results in Table 1 show that households mostly have access to a bicycle (72% of respondents) and ox-carts (60% of the respondents). Ox-carts are particularly important for transportation of harvest from the farms to the market. We also collected information on livestock asset ownership, as these are often a form of savings that can be used as a buffer stock to insulate consumption from income fluctuations.

Other household characteristics that affect market participation included access to credit, access to storage, membership of cooperatives, and whether farmers had already promised part of the 2022 harvest to a buyer. Table 2 shows that among the surveyed farmers, about 40 percent indicate that they have access to credit, and that less than a quarter had outstanding debts averaging MWK. 57,000 to repay after harvest. With regards to access to storage, 60 percent of the households reported that they have access, of which half indicated that the storage was crop specific. We also find that, while farmer participation in cooperatives is limited, a moderate share (40%) have access to storage space provided by the cooperative. Lastly, we look at the proportion of farmers that commit a part of their crop to buyers before harvest—a scenario that may often lead farmers to sell at unfavorable prices, or reduces the amount of harvest that farmers can sell after harvest. We find that only a negligible share of farmers (8%) had already promised (part of) the 2022 crop to buyers prior to harvest.

4.2 Baseline balance

We follow our pre-analysis plan and test baseline balance by constructing a standard balance table consisting of the following variables household/demographic characteristics (inspired by balance tables in Duflo, Kremer, and Robinson

Table 1: Household characteristics

	Mean	Std dev	N
Household head			
Household head is male (1=yes)	0.791	0.407	3,534
Age of household head (years)	43.426	14.831	3,414
Schooling of household head (years)	6.329	3.489	3,427
Roof of main building is grass thatch (1=yes)	0.609	0.488	3,534
Household characteristics			
Roof of main building is corrugated iron (1=yes)	0.39	0.488	3,534
Household size (number of people)	5.043	1.992	3,530
Number of rooms in the house	3.202	1.178	3,534
Distance (kms) to nearest all weather road	1.308	3.433	3,346
Distance (kms) to nearest market	4.107	4.78	3,243
Transport			
Household has access to bicycle (1=yes)	0.719	0.45	3,534
Household has access to saloon car (1=yes)	0.218	0.413	3,534
Household has access to pick-up or lorry access (1=yes)	0.221	0.415	3,534
Household has access to ox-cart (1=yes)	0.595	0.491	3,534
Household owns a motorbike (1=yes)	0.11	0.313	3,534
Livestock assets			
Number of bulls/oxen/steers owned by household	0.123	0.653	3,533
Number of cows or heifers owned by household	0.128	0.799	3,532
Number of calves owned by household	0.053	0.495	3,533
Number of pigs owned by household	0.708	1.943	3,534
Number of goats owned by household	1.241	2.569	3,533
Number of sheep owned by household	0.055	0.519	3,531
Number of chicken owned by household	4.743	6.509	3,532
Number of ducks owned by household	0.282	1.501	3,533

Table 2: Household characteristics that affect market participation

	Mean	Std dev	N
		Credit	
Do you have access to credit? (1=yes)	0.383	0.486	3,532
Do you have debts (cash or in-kind) to be repaid after harvest? (1=yes)	0.236	0.425	3,532
Estimated amount (Malawian Kwacha) of debt	56,878	92,788	819
		Storage	
Do you have access to storage? (1=yes)	0.599	0.49	3,532
Is the storage crop specific? (1=yes)	0.482	0.5	2,114
		Cooperation	
Are you member of a Cooperatives? (1=yes)	0.134	0.34	3,532
Does this cooperative provide access to storage? (1=yes)	0.388	0.488	472
Is this Cooperative certified by the Agriculture Commodity Exchange? (1=yes)	0.727	0.446	472
		Advance selling	
Did you already promise part of the 2022 harvest to a buyer? (1=yes)	0.077	0.267	3,532

(2011); Karlan et al. (2014)): household head is female (1=yes), household size (number of people), age of household head (years), number of years of education of the household head (years), material of roof (corrugated iron = 1), number of rooms in the house, cultivated acreage (maize+groundnuts+soybean), whether the household hired in agricultural labour (1=yes), distance to nearest all weather road (km), and distance to nearest market (km). We report t-tests comparing treatment and control (unadjusted for multiple hypothesis testing) as well as a joint F-test from a regression of the treatment assignment on all variables in the balance table. Results are summarized in Table 3.

We find significant imbalance on some of the variables, particularly for the sales plan treatment (T2). While joint F-test for separate treatment control comparisons are not significant, we do find signs of imbalance when we us a likelihood ratio test derived from a multinomial model where the left hand side has three levels (T1, T2, Ctrl).

The pre-analysis plan also states that we assess balance on a range of characteristics that we will use to investigate heterogeneous treatment effects. The variables mentioned there are access to credit, access to storage facility, membership of (marketing related) cooperative, livestock asset ownership, and whether the household already makes a budget. Results for these variables are in Table 4.

5 Impact at midline

5.1 Attrition

As data collection for the September midline was by phone, we expected that we would not be able to reach some farmers, even though at baseline we always collected information on alternative ways to reach the farmers (for instance through village headship). From the original 3534 farmers that were interviewed at baseline, we successfully reached 3382 farmers, leading to an attrition rate of just under 5 percent. Enumerators made on average 10 attempts before indicating the farmers could not be reached. Treatments are not correlated to the likelihood that farmers are missing from the data (χ^2 test of independence of proportions is rejected at p=0.912).

5.2 Primary outcomes

We start with the most parsimonious specification by reporting simple difference between treatment and control farmers obtained from an Ordinary Least Squares regression that regresses the outcome of interest on two dummy variables indicating if the household received T1 or T2 respectively. Results are in the top panel of Table 5. In the bottom panel of Table 5 we show results after including additional controls. These include the outcome at baseline, baseline variables for which we found imbalance in Table 3, and village fixed effects. We start with Table 5, which reports results for maize; Tables 6 and 7 are similar

Table 3: Balance table

	mean ctrl	T1	T2	nobs
Household head is female	0.219	-0.022	-0.011	3534
	(0.413)	(0.016)	(0.016)	
Household size (number of people)	5.011	-0.017	0.19*	3534
	(2.04)	(0.083)	(0.083)	
Age of household head (year)	43.138	-0.018	0.977	3414
	(14.885)	(0.608)	(0.61)	
Years of education of household head	6.237	0.248+	0.107	3428
	(3.457)	(0.14)	(0.14)	
Roof of main building is corrugated iron	0.37	0.029	0.038*	3534
	(0.483)	(0.019)	(0.019)	
Number of rooms in house	3.174	0.042	0.058	3534
	(1.17)	(0.046)	(0.046)	
Area of cultivated land (acres)	2.452	0.06	0.204**	3489
	(1.736)	(0.071)	(0.071)	
Hired labour for maize, soybean or gnut productions?	0.408	0.015	0.059**	3528
	(0.492)	(0.02)	(0.02)	
Distance to nearest all weather road (km)	1.415	0.348	-0.092	3350
	(4.585)	(0.257)	(0.258)	
Distance to nearest market (km)	4.342	0.584	-0.059	3251
	(8.407)	(0.377)	(0.377)	
F-test C/T1 (p-value)	1.064	(0.386)		
F-test C/T2 (p-value)	1.414	(0.168)		
Likelihood Ratio Test (p-value)	29.229	(0.083)		

Note: First column reports control group means (and standard deviations below); **, * and +
denote significance at the 1, 5 and 10 percent levels. F-test test for joint significance in a regression
with treatment status on the left hand side (T1/C or T2/C). Likelihood ratio test is derived from a
multinomial model where the left hand side has three levels (T1,T2,C). All models include village
fixed effects.

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Table 4: Balance table for conditioning variables

	mean ctrl	T1	T2	nobs
Household has access to credit	0.384	0.002	-0.008	3534
	(0.487)	(0.019)	(0.019)	
Household has access to storage	0.592	0.004	0.02	3534
	(0.492)	(0.019)	(0.019)	
Cooperative member	0.137	-0.012	-0.001	3534
	(0.344)	(0.014)	(0.014)	
Has livestock	0.484	0.012	0.041*	3532
	(0.5)	(0.02)	(0.02)	
Makes a budget	0.694	0.008	0.012	3534
	(0.461)	(0.018)	(0.018)	
F-test C/T1 (p-value)	0.284	(0.922)		
F-test C/T2 (p-value)	1.176	(0.318)		
Likelihood Ratio Test (p-value)	7.452	(0.682)		

Note: First column reports control group means (and standard deviations below); **, * and + denote significance at the 1, 5 and 10 percent levels. F-test test for joint significance in a regression with treatment status on the left hand side (T1/C or T2/C). Likelihood ratio test is derived from a multinomial model where the left hand side has three levels (T1,T2,C). All models include village fixed effects.

tables but for groundnuts and soybean, respectively.

A first primary outcome we consider is stocks held of the commodity at the time of the midline survey. In particular, we asked farmers how many bags of the commodity (standard 50 kg bags) they have in store. As the distributions are skewed to the right and includes zeros as well, we use an inverse hyperbolic sine transformation (Bellemare and Wichman, 2020). For both treatments, we expect a positive effect. Similar to Augenblick et al. (2021), we expect that when making households aware about future needs, they will reduce discretionary expenditures and save more for the future. Furthermore, if farmers expect prices to go up over time and this is reflected in their sales plan, farmers that are encouraged to commit to this sales plan will also be more likely to have saved more early on in the season.

We see that the average control farmer has about 5.565 bags of maize in store at the time of the survey. We do not find that this is significantly different in the sample of farmers that were taken through a budgeting exercise. However, we do find that stocks are significantly higher among farmers that made a sales plan. Farmers that were asked to commit to a sales plan have stocks that are about 13.4 percent higher than maize stocks of farmers in the control group. If we add controls to the regression, the effect reduces substantially and falls just below the significance threshold.

A second primary outcome tests if the household sold any of the crop in the interval between the intervention and the midline survey. For similar reasons why we expect stocks to be higher, we expect that the treatment would reduce

the likelihood of selling early on in the season. We find that 34.1 percent of households in the control group indicated that they made at least on sales transaction between in the first few months after the start of the project. We do not find that this proportion differs for farmers in T1 nor for farmers in T2.

The third primary outcome is related to the second and is the quantity that was sold during the period between the intervention and the first midline survey. While we may not find that the treatment reduced the fact that farmers sell early, we may still find that farmers sell less of the crop immediately after harvest. We find that farmers in the control group sell on average 1.528 bags of maize. Contrary to our expectations, we see that these quantities are higher in both treatment groups, but the differences are not significant.

For farmers that did engage in sales, we can calculate the average price that farmers received for their crop. The aim of the intervention is to increase the price at which farmers sell. The farmers that sold in the control group got on average 224.349 MKW per kilogram of maize. We again do not find that prices differ significantly in any of the treatment groups.

We also consider behaviour related to purchases of the commodities as key primary outcomes. We expect that, especially later in the season, due to our interventions households will have to buy back less. We see that in the control group, of the farmers that already sold maize, about 17 percent also made at least one purchase of maize before midline and this proportion is similar in both treatment groups.[1] As for sales, we also look at quantities bought and prices at which the commodities were bought. We find that for maize, the average control group household bought less than one bag on average and paid slightly more than the sales price. We do not see any effects from the interventions.

In Table 6, we repeat the entire analysis, but now for groundnuts. Households in the control group remain with less than 2 bags of groundnuts in stock. Also here, we see that households that drew up a sales plan (T2) have stocks that are about 10.6 percent higher than in the control group. For groundnuts, we also see that stocks are significantly higher in the group that was asked to make a detailed expenditure plan (T1).

A surprisingly larges share of households, over two thirds, indicate that they made at least one sales transaction between the intervention and the midline survey. However, it should also be noted that many households indicate that they did not cultivate groundnuts. Also surprising is that we find that households with a sales plan are more likely to have already sold—5.4 percentage points more according to the full model in the second panel of Table 6—and appear to have sold large quantities. Prices (here expressed in MKW per debe) do not appear to be different from the control group.

As for maize, we also asked if farmers that sold groundnuts also already bought groudnuts in the first few months post harvest. Only about 8 percent of farmers report buy back behaviour. However, we do find that farmers that were asked to create a budget are less likely to be both buying and selling. Finally,

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[1]We also ran the analysis for buying behaviour of all farmers instead of only farmers that sold. Results were very similar.

Table 5: Primary outcomes maize

	mean ctrl	T1	T2	nobs
		treatment-control		
Stocks (abs)	5.565	0.04	0.134*	3381
	(10.657)	(0.052)	(0.052)	
Sold (yes/no)	0.341	-0.004	0.005	3270
	(0.474)	(0.02)	(0.02)	
Quantity sold (abs)	1.528	0.053	0.032	3263
	(3.823)	(0.043)	(0.043)	
Price sold (MKW)	224.349	4.402	1.434	1109
	(55.837)	(3.87)	(3.866)	
Bought (1=yes)	0.173	0.012	0.024	1228
	(0.379)	(0.027)	(0.027)	
Quantity bought	0.73	0.014	0.047	1226
	(2.491)	(0.054)	(0.054)	
Price bought	257.889	1.486	3.027	225
	(40.848)	(8.098)	(7.861)	
		full models		
Stocks (abs)	5.565	0.016	0.062	3333
	(10.657)	(0.043)	(0.043)	
Sold (yes/no)	0.341	-0.004	-0.003	3224
	(0.474)	(0.019)	(0.019)	
Quantity sold (abs)	1.528	0.051	0.002	3217
	(3.823)	(0.041)	(0.041)	
Price sold (MKW)	224.349	3.244	-0.478	1086
	(55.837)	(3.768)	(3.778)	
Bougth	0.173	0.007	0.027	1203
	(0.379)	(0.026)	(0.026)	
Amount bougth	0.73	0.008	0.051	1201
	(2.491)	(0.054)	(0.053)	
Price bougth	257.889	-7.028	-4.471	219
	(40.848)	(9.694)	(9.667)	

Note: First column reports control group means (and standard deviations below); mean stock is current situation in 50kg bags, ATE is ihs transformed. Sold or bought is since intervention untill midline survey, quantity bought/sold is total quantity between intervention and midline survey, prices are average prices of transactions that occured between intervention and midline survey **, * and + denote significance at the 1, 5 and 10 percent levels. All models include village fixed effects and controls for baseline characteristics that show imbalance at the 5 percent level or less in Table XXX.

we also do not find an impact on prices at which groundnuts were purchased, but as very few farmers bought groundnuts, sample size becomes too small to obtain reliable estimates.

Finally, Table 7 shows impact of the interventions on primary outcomes for soybean. Interestingly, we do not find that that stocks for soybean at midline differ significantly between treatment groups and the control. We also do not find that sales behaviour in any of the treatment groups differs from sales behaviour on the control group. We do find, however, that treated households that sold already were also significantly less likely to already have bought soybean and that the average quantities are significantly lower for households that made a sales plan.

5.3   Secondary outcomes

In this section, we look at some additional outcome which may be indirectly affected by the interventions. These outcomes may help explain some of the effect on primary outcomes, or they may be outcomes for which the expected effects are ambiguous. We again present separate tables for maize (Table 8), for groundnuts (Table 9) and for soybean (Table 10).

A first outcome we look at is the price in the near future. In particular, we asked all households what they expected the price would be around the end of the year. Table 8 shows that farmers still expect a sizable price increase: while we saw in the previous section that the average farmer in the control group only got about 225 MKW per kilogram of maize during the first few months after harvest, the price is expected to increase to about 380 per kilogram around new year. Interestingly, we see that farmers who were taken through a budgeting exercise expect prices to be higher still.

We also wonder if our intervention would affect intra-household dynamics, in particular who is in charge of sales of the commodity. We see that in about 37 percent of households, the decisions related to the sales of maize is taken by the male and female co-head jointly, with both co-head having equal voice. We do not find that decision making is affected by the interventions.

Another secondary outcome we consider is related to who was sold to. In particular, we test if, in response to our interventions, farmers increase the likelihood that they sell directly to the market, as this is often the place where they can get the best price for their crop Fafchamps and Hill (2005). We find that very few farmers in our sample sell maize directly to the market, and that there are no difference between the different treatment groups.

Finally, we asked farmers that sold between the harvest and the midline survey what the proceeds from the transaction was used for. We examine the effect of our interventions on two categories. One expenditure type, payment of school fees, is likely to be predictable by the farmer. A second expenditure type, health related expenses, is probably less predictable. We do not find that the treatment intervention changed the propensity that sales of maize were made for any of these expenses.

Table 6: Primary outcomes gnuts

	mean ctrl	T1	T2	nobs
		treatment-control		
Stocks (abs)	1.716	0.071$^+$	0.106*	3381
	(7.124)	(0.041)	(0.042)	
Sold (yes/no)	0.674	0.009	0.038	1704
	(0.469)	(0.027)	(0.027)	
Quantity sold (abs)	3.909	0.008	0.138$^+$	1689
	(6.334)	(0.072)	(0.071)	
Price sold (MKW)	4855.443	85.648	27.597	1154
	(1093.01)	(82.348)	(80.658)	
Bought (1=yes)	0.08	-0.019	-0.009	2850
	(0.271)	(0.012)	(0.012)	
Quantity bought	0.114	-0.02	-0.007	2839
	(0.578)	(0.014)	(0.014)	
Price bought	5296.629	349.204	-71.139	188
	(1903.552)	(343.585)	(336.956)	
		full models		
Stocks (abs)	1.716	0.059$^+$	0.063$^+$	3333
	(7.124)	(0.035)	(0.036)	
Sold (yes/no)	0.674	0.022	0.054*	1678
	(0.469)	(0.027)	(0.026)	
Quantity sold (abs)	3.909	0.018	0.156*	1665
	(6.334)	(0.066)	(0.066)	
Price sold (MKW)	4855.443	35.676	10.178	1130
	(1093.01)	(76.576)	(74.999)	
Bougth	0.08	-0.02$^+$	-0.011	2804
	(0.271)	(0.012)	(0.012)	
Amount bougth	0.114	-0.023	-0.009	2794
	(0.578)	(0.014)	(0.014)	
Price bougth	5296.629	102.983	-368.712	185
	(1903.552)	(405.234)	(391.279)	

Note: First column reports control group means (and standard deviations below); **, * and +
denote significance at the 1, 5 and 10 percent levels. All models include village fixed effects and
controls for baseline characteristics that show imbalance at the 5 percent level or less in Table XXX.

Table 7: Primary outcomes soy

	mean ctrl	T1	T2	nobs
		treatment-control		
Stocks (abs)	1.114	0.005	0.05	3381
	(3.551)	(0.032)	(0.033)	
Sold (yes/no)	0.55	0.003	0.033	2447
	(0.498)	(0.024)	(0.024)	
Quantity sold (abs)	2.376	-0.019	0.084	2438
	(4.347)	(0.054)	(0.053)	
Price sold (MKW)	565.29	-5.195	-2.73	1367
	(144.846)	(9.817)	(9.558)	
Bought (1=yes)	0.075	-0.029*	-0.029*	2307
	(0.264)	(0.012)	(0.012)	
Quantity bought	0.06	-0.006	-0.02^{+}	2298
	(0.426)	(0.01)	(0.01)	
Price bought	639.726	-30.694	24.79	135
	(197.716)	(42.758)	(42.758)	
		full models		
Stocks (abs)	1.114	-0.003	0.017	3333
	(3.551)	(0.029)	(0.029)	
Sold (yes/no)	0.55	0.011	0.033	2405
	(0.498)	(0.024)	(0.024)	
Quantity sold (abs)	2.376	-0.012	0.082	2399
	(4.347)	(0.051)	(0.051)	
Price sold (MKW)	565.29	-2.045	-1.063	1350
	(144.846)	(9.73)	(9.491)	
Bougth	0.075	-0.029*	-0.027*	2283
	(0.264)	(0.012)	(0.012)	
Amount bougth	0.06	-0.008	-0.02^{+}	2276
	(0.426)	(0.01)	(0.01)	
Price bougth	639.726	4.951	68.165	132
	(197.716)	(57.493)	(52.984)	

Note: First column reports control group means (and standard deviations below); **, * and +
denote significance at the 1, 5 and 10 percent levels. All models include village fixed effects and
controls for baseline characteristics that show imbalance at the 5 percent level or less in Table XXX.

Table 8: Secondary outcomes maize

	mean ctrl	T1	T2	nobs
	treatment-control			
Expected price (dec)	379.339	7.64$^+$	-1.011	3377
	(107.932)	(4.591)	(4.609)	
Sold jointly	0.368	-0.001	0.024	1181
	(0.483)	(0.034)	(0.034)	
Sold to market	0.051	-0.002	0	1181
	(0.22)	(0.015)	(0.015)	
Pay education	0.174	0.01	-0.016	1181
	(0.379)	(0.027)	(0.026)	
Pay health	0.121	0.011	-0.009	1181
	(0.326)	(0.023)	(0.023)	
	full models			
Expected price (dec)	379.339	7.693$^+$	-2.36	3329
	(107.932)	(4.394)	(4.423)	
Sold jointly	0.368	0.012	0.005	1157
	(0.483)	(0.028)	(0.028)	
Sold to market	0.051	-0.007	-0.001	1157
	(0.22)	(0.015)	(0.015)	
Pay education	0.174	0.009	-0.017	1157
	(0.379)	(0.027)	(0.027)	
Pay health	0.121	0.012	-0.015	1157
	(0.326)	(0.024)	(0.024)	

Note: Sold jointly is one if all transactions between intervention and midline were taken by co-heads together, sold to market is 1 if all sales between intervention and midline were to the market. First column reports control group means (and standard deviations below); **, * and + denote significance at the 1, 5 and 10 percent levels. All models include village fixed effects and controls for baseline characteristics that show imbalance at the 5 percent level or less in Table XXX.

Table 9: Secondary outcomes gnuts

	mean ctrl	T1	T2	nobs
		treatment-control		
Expected price (dec)	7811.299	111.451	-126.976	3381
	(2442.11)	(101.788)	(102.187)	
Sold jointly	0.405	-0.021	0.014	1221
	(0.491)	(0.034)	(0.034)	
Sold to market	0.026	0.002	0	1221
	(0.161)	(0.011)	(0.011)	
Pay education	0.145	0.052*	0.03	1221
	(0.352)	(0.026)	(0.026)	
Pay health	0.063	-0.023	0.008	1221
	(0.243)	(0.016)	(0.016)	
		full models		
Expected price (dec)	7811.299	88.634	-155.786+	3333
	(2442.11)	(89.668)	(90.262)	
Sold jointly	0.405	-0.015	-0.003	1196
	(0.491)	(0.027)	(0.026)	
Sold to market	0.026	0.005	0.003	1196
	(0.161)	(0.011)	(0.011)	
Pay education	0.145	0.044+	0.037	1196
	(0.352)	(0.026)	(0.026)	
Pay health	0.063	-0.025	0.01	1196
	(0.243)	(0.017)	(0.017)	

Note: First column reports control group means (and standard deviations below); **, * and +
denote significance at the 1, 5 and 10 percent levels. All models include village fixed effects and
controls for baseline characteristics that show imbalance at the 5 percent level or less in Table XXX.

Turning to Table 9 for secondary outcomes of groundnuts, we see that farm-
ers in the control group expect a further 60 percent increase of the price by the
end of the year. Now, we see that farmers that were asked to provide a sales
plan estimate that future prices will be lower than what control group farmers
think.

We further find that decisions related to the sales of groundnuts are made
jointly in slightly more households than was the case for maize. However, also
here, there is no effect of the interventions. Groundnuts are rarely sold directly
to the market, and there is also no effect of T1, nor T2. For the expense
categories, we see that households that were asked to provide a detailed budget
are more likely to have sold groundnuts to pay for school fees than farmers in
the control group.

Finally, Table 10 shows results for secondary outcomes for soybean. Control
group farmers estimate that prices will be almost double what they were during
the first few months post harvest. As was the case for groundnuts, farmers that

Table 10: Secondary outcomes soy

	mean ctrl	T1	T2	nobs
	treatment-control			
Expected price (dec)	1095.522	5.913	-20.266	3381
	(323.506)	(13.371)	(13.423)	
Sold jointly	0.27	0.01	-0.001	2237
	(0.444)	(0.023)	(0.023)	
Sold to market	0.029	-0.003	0.007	2237
	(0.168)	(0.009)	(0.009)	
Pay education	0.1	0.009	-0.008	2237
	(0.3)	(0.015)	(0.015)	
Pay health	0.027	-0.007	0	2237
	(0.162)	(0.008)	(0.008)	
	full models			
Expected price (dec)	1095.522	5.268	-21.486^{+}	3333
	(323.506)	(12.633)	(12.716)	
Sold jointly	0.27	0.015	0	2195
	(0.444)	(0.021)	(0.02)	
Sold to market	0.029	-0.003	0.004	2195
	(0.168)	(0.009)	(0.009)	
Pay education	0.1	0.005	-0.011	2195
	(0.3)	(0.016)	(0.015)	
Pay health	0.027	-0.008	0	2195
	(0.162)	(0.008)	(0.008)	

Note: First column reports control group means (and standard deviations below); **, * and +
denote significance at the 1, 5 and 10 percent levels. All models include village fixed effects and
controls for baseline characteristics that show imbalance at the 5 percent level or less in Table XXX.

were assigned to the sales plan treatment (T2) provide slightly lower estimates
for the price at the end of the year than farmers in the control group.

There is significantly less joint decision making when it comes to sales of
soybean. However, also here, who makes decisions is not affected by the in-
terventions. Results for who was sold to are similar to those for groundnuts.
We also do not find any impact of the interventions on what happens with the
proceeds from soybean sales.

Conclusion

In this paper, we test two behavioral explanations for the "sell low-buy high"
puzzle. The first explanation assumes that farmers underestimate how much
money they will need later on in the season, leading them to sell too much
immediately post harvest at prices that are too low. We test this explanation
through an intervention in which households are asked to prepare a detailed

budget of what they will need for the entire year. It is expected that by making future expenditure more explicit, farmers will suffer less from budget neglect when making market participation decisions.

The second explanation assumes that farmers face challenges in planning and committing on the income side. For a variety of reasons such as temptation, emergencies or social pressures, farmers are assumed to sell earlier than they would like to, and at lower prices than they envisioned. We test this using a light touch intervention where we ask farmers to prepare a detailed sales plan, indicating how much of each crop will be sold when during the coming year, and what the minimum price is they want for it, and hope this serves as a commitment device for the farmer.

We implement our field experiment in a sample of about 3500 farmers in four districts in the Central and Northern Regions of Malawi. Treatments were administered during baseline data collection immediately after the maize harvest in April 2022. Results in this paper are based on a first (telephone based) midline survey, which was done in September 2022.

We find some evidence that households that were exposed to the interventions remain with higher stocks at the time of the midline survey. The effect on stocks is strongest for groundnuts and for the treatment that involves drawing up a sales plan. We also find that for groundnuts, households that committed to a detailed plan on when to sell and at what price were more likely to have sold already during the first few months after the intervention, and sold larger quantities. Finally, we find some evidence that farmers that were exposed to the treatment were less likely to engage in buying soybean. For secondary outcomes, there is some evidence that farmers who are asked to draw up a sales plan expect more modest price increases than farmers in the control group.

While the results are much more muted that for example that large increases in savings found immediately after implementing a similar budgeting intervention in Augenblick et al. (2021) in Zambia, we do think that results are encouraging. We do for instance find that for the crop that is harvested first (and so households are likely to start running out of stock earlier) households that were exposed to the treatment were less likely to have bought the crop. Furthermore, as this is analysis is based on only a first midline survey done only three months after the intervention, we expect that many of the effects (such as the effect on sales prices) will become stronger in future rounds of data collection.

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