Agricultural Economics

WILEY

AGRICULTURAL ECONOMICS
The Journal of the International Association of Agricultural Economists

ORIGINAL ARTICLE OPEN ACCESS

Unpacking Side-Selling: Experimental Evidence From Rural Mexico

Stephen Pitts[1] | Chris M. Boyd[2] | Grant X. Storer[3]

[1]Department of Economics, Marquette University, Milwaukee, Wisconsin, USA | [2]Department of Economics, Towson University, Towson, Maryland, USA | [3]Department of Economics, University of San Francisco, San Francisco, California, USA

Correspondence: Stephen Pitts (stephen.pitts@marquette.edu)

Keywords: coffee | cooperatives | framed field experiment | Mexico | price risk | side-selling

ABSTRACT

With the rise of market-led development, marketing cooperatives have emerged that offer smallholder producers a guaranteed minimum price for their cash crops. Their existence is threatened when members side-sell a part of their harvest to outside buyers. We conduct a framed field experiment with indigenous coffee producers in southern Mexico to examine the effect of four factors on the marketing decision: additional income, the presence of microcredit and/or technical assistance, average outside buyer price, and harvest quantity. Our results show that participants allocate on average 82% of their harvest to the certain-price buyer. Changes in harvest quantity and outside-buyer price have minimal effects. The offer of complementary services has a null effect. Moreover, 22% of the participants always allocate their entire harvest to the certain-price buyer. Extra income increases this probability by 10%. Subgroup analysis reveals that this effect is limited to existing cooperative members.

JEL Classification: C91, C93, D81, O13, Q13

1 | Introduction

Smallholder agricultural producers face a variety of market imperfections that reduce the welfare they receive from the sale of their cash crops: output price volatility, monopsony power by traders, and transaction costs.[1] In many developing countries, state-backed organizations, such as commodity boards, alleviate these market imperfections by providing price insurance and other services to producers. However, in recent years, governments have reduced or eliminated these agricultural support programs. As a result, market-based organizations such as producer cooperatives have emerged in their place. Since they lack state support, however, these producer cooperatives depend on the continued loyalty of their members to finance their services, which often improve welfare over the medium- and long-term. When members sell a portion of their harvest to outside traders in the short-term, this side-selling threatens the economic viability of cooperatives.

Empirical estimates of the incidence of side-selling vary widely: 12% (Keenan et al. 2024; Woldie 2010; Wollni and Fischer 2015), 20% (Ewusi Koomson et al. 2022), 30% (Alemu et al. 2021; Arana-Coronado et al. 2019), 40% (Gerard et al. 2021), or 55% (Fischer and Qaim 2014; Geng et al. 2023). Moreover, the amount of side-selling varies both among producers in the same cooperative and within the same producer over different marketing years. Wollni and Fischer (2015) find that side-selling behavior follows the U-shaped pattern first reported by Fafchamps and Hill (2005) regarding producer marketing decisions. Farmers with a low or high production quantity are more loyal to a cooperative. The former cannot pay the fixed cost of side-selling, and the latter are not as affected by the liquidity constraints that often drive side-selling. In addition, production shocks (Keenan et al. 2024) and liquidity shocks (Geng et al. 2023) can also increase side-selling from one year to the next in the same producer. Finally, risk aversion (Binswanger 1980), length of cooperative membership (Bhuyan 2007), and the presence of complementary services such as microcredit or technical assistance (Mujawamariya et al. 2013) are also associated with side-selling.

In this paper, we use a framed field experiment to determine the effect of four factors on side-selling: production shocks, income shocks, transaction cost shocks, and nudge reminders of complementary services. Participants play 60 rounds of a game in which each round corresponds to a marketing year. In a given round, they must allocate their harvest across a certain-price and an uncertain-price buyer.[2] In order to estimate the value participants place on the services offered by the certain-price buyer, we vary its description: certain price; certain price and microcredit; certain price, microcredit, and technical assistance. Moreover, we vary the harvest quantity and the mean of the price offered by the uncertain-price buyer to estimate the effect of production shocks and transaction cost shocks, respectively, on marketing behavior. Finally, we give half of the participants additional income from another source to estimate the effect of an income shock. Our experiment integrates these four separate sources of variation that prior work has associated with side-selling. To our knowledge, we are the first to use an experiment to study side-selling.

Our results are as follows. First, price certainty matters at both the intensive and extensive margins. At the overall margin, producers allocate on average 82% of their harvest to the certain- price buyer. At the extensive margin, 22% of the producers (58 of 268) allocate their entire harvest to the certain-price buyer in each round. This estimate of an 18% incidence of side-selling approaches the lower bound of the empirical results above. It suggests that in cases where cooperatives offer a fixed price and outside traders a variable price, side-selling behavior, or its inverse, producer loyalty to cooperatives, is associated with producer risk preferences.

Second, additional income influences side-selling at the extensive margin but not at the intensive margin. At the extensive margin, it increases by 10% a producer's probability of selling the entire harvest to the certain-price buyer in each round. At the intensive margin, it does not affect round-level performance. When we estimate the extensive margin of the effect of the additional income separately for cooperative members and non-members, we find significant heterogeneity in the treatment effects: 17% for members and 2% for non-members. The former effect is significant at the 5% level and the latter is not significant. Two additional moderator analyses give additional information on the mechanisms behind the effect of additional income. First, for cooperative members, the treatment effect of additional income decreases with the number of years of cooperative membership: for a new member it is 42% and decreases by 3% for each year of membership. Second, the treatment effect varies depending on cooperative membership and risk aversion, as measured by a no-loss lottery based on that of Eckel and Grossman (2008). For the least risk-averse cooperative members (CRRA near 0), it is 7%. From there it increases to 31% for the most risk-averse cooperative members (CRRA near 2). For the least risk-averse cooperative non-members, it is 6%. From there it decreases to −29% for the most risk-averse cooperative non-members. None of these effects are statistically significant.

Third, production shocks affect the marketing decision by at most 3% in either direction. Thus, we confirm the U-shaped behavior reported by Wollni and Fischer (2015) and Keenan et al. (2024). Though our point estimates are small, they are similar in magnitude to these results. Finally, nudge reminders of complementary services do not affect the marketing decision. This result differs from that of Mujawamariya et al. (2013) and suggests that behavioral economics may not offer a solution to side-selling (Wuepper et al. 2023).

Our results contribute to three distinct strands of literature. First, we contribute to the literature on marketing decisions of agricultural producers. Previous literature has examined the determinants of participation in cooperatives (Bernard and Spielman 2009; Mojo et al. 2017) and intensity of participation in cooperatives (Bhuyan 2007; Fischer and Qaim 2014; Klein et al. 1997; Mujawamariya et al. 2013) using reduced-form models on cross-sectional data sources. Fafchamps and Hill (2005), Woldie (2010), and Wollni and Fischer (2015) propose structural models and test their predictions, once again on cross-sectional data. Our work goes deeper. Instead of the likelihood or intensity of cooperative participation, we examine the demand for the services that cooperatives typically provide. Our results provide insight into the mechanisms behind how much and under what conditions cooperative members market their agricultural production through cooperatives.

Second, we contribute to the literature on the use of experiments to understand producer decision making. Palm-Forster and Messer (2021) provides a recent review of the use of experiments to study the behavior of agricultural producers. Framed field experiments are not new, as the pioneering work of Binswanger (1980) demonstrates. However, they are still as relevant in 2025 as in 1980. They improve on the internal validity of the cross-sectional research above at a fraction of the cost of a randomized control trial. Moreover, they allow for the study of more variation. Casaburi and Reed (2022) pay bonuses to a random subset of traders to examine effects further down the value chain. We too could have randomly subsidized coffee producers with additional income, but at the expense of losing the three other sources of variation in our experiment. The subsidies alone would have cost as much as the entire budget of our experiment.

Our experiment is most similar to three recent experiments. Bellemare et al. (2020) test the prediction of Sandmo (1971) that producers reduce production in situations of price risk and finds that this prediction does not hold. Boyd and Bellemare (2022) both corroborate this finding and also find that the provision of insurance causes producers to increase production in situations of price risk. Mattos and Zinn (2016) find evidence for the existence of producer reference prices in marketing decisions. These three experiments survey a mix of 119 college students and producers, 101 producers, and 75 producers, respectively. Our sample size of 268 producers improves on the external validity of all three experiments, especially since we confirm their findings in a different context.

Third, we contribute to the small literature on price risk (Boyd and Bellemare 2020). In situations of output price risk, Newbery and Stiglitz (1981) propose methods for evaluating the welfare effects of commodity price stabilization programs. Their work and much of the following work focus on the differential effects of such programs depending on whether agricultural households are net buyers or sellers of the good in question (Barrett 1996; Bellemare et al. 2013; Finkelshtain and Chalfant 1991). Our situation differs for two reasons. First, coffee is a cash crop, not a staple, so we do not need to consider the producers' own welfare as consumers. Second, most smallholder producers do not have the infrastructure to store coffee from year to year. Thus, there is no opportunity for arbitrage between growing seasons, just as in the case of the Kenyan roses that Macchiavello and Morjaria (2015) study.

Instead, our work complements that of Bellemare et al. (2021), who consider producers that face output price risk and can allocate their production between a contract that pays a fixed price and an intermediary who pays the market price. They find that contract farming reduces participants' income variability, which they proxy with the residual from a cross-section regression. Moreover, they find that participation in contract farming schemes would be more beneficial for producers who do not participate than it is for those who do. Our sixty-round experiment extends these results, since we can observe producer behavior over many simulated growing seasons and producers can in effect choose the amount of income variability to which they are exposed. Our work also shows the fragility of informal price insurance schemes, especially in years when the market beats the contract and producers are liquidity-constrained.

Our paper proceeds as follows. Section 2 gives background on coffee production worldwide and in Mexico and describes the context where we conducted the experiment. Section 3 describes the design of the experiment and relates it to previous work. Section 4 describes our data and gives descriptive statistics. Section 5 presents the empirical strategy we use to test the effect of the four additional factors on the marketing decision. Section 6 presents and discusses the results, at the participant-round-game level, the participant-round level and the participant level. It also presents results of subgroup and moderation analysis. Section 7 gives policy implications and concludes.

2 | Context

In this section, we first describe the situation of smallholder coffee producers in Chiapas, Mexico. Next, we describe two different development strategies that have sought to improve their welfare and the welfare of other smallholder producers in the developing world: state-led development and market-led development.[3] We touch briefly on the macroeconomic factors that led to a transition from state-led development to market-led development in the early 1990s. Third, we describe the particular institutional features of our partner cooperative. Finally, we describe the challenge that side-selling poses to the cooperative.

Worldwide, coffee is cultivated on approximately 12.5 million farms. Ninety-five percent of coffee producers have farms no larger than 5 ha, and eighty-four percent have farms of 2 ha or less. For many producers, coffee is their primary cash crop, and therefore their annual income depends on two factors: the yield of their harvest and the world price of coffee. Mexico is the tenth largest coffee producer in the world.[4]

Although our analysis focuses on smallholder Mexican coffee producers, the issues here are not limited to Mexico or coffee. The picture we paint here is broadly similar to the situation of smallholder producers of specialty crops in Latin America and elsewhere who are members of cooperatives (Pitts 2019). Side-selling has been observed with coffee producers in Peru (Keenan et al. 2024), coffee producers in Burundi (Gerard et al. 2021), coffee producers in Costa Rica (Wollni and Fischer 2015), banana producers in Ethiopia (Woldie 2010), dairy producers in Kenya (Geng et al. 2023), sorghum producers in Kenya (Nyamamba et al. 2022), and barley producers in Ethiopia (Alemu et al. 2021). In all of these contexts, cooperatives offer value chain integration, quality upgrading, and microcredit to smallholder agricultural producers, but the provision of these services is hindered by producer members who do not market their harvest through the cooperative.

2.1 | Smallholder Mexican Coffee Production

Our setting is a group of indigenous Mexican coffee producers in the state of Chiapas in southern Mexico. Coffee is the primary cash crop for these producers. They typically produce 4 quintals (240 kg) on 1–2 ha of land and sell their coffee for MXN 70–80 (approximately US$3.50)/kg. Thus, they earn around US$1000, which they use to purchase everything they do not grow for themselves.[5] Typically, they grow corn and vegetables for their own consumption.

Coffee has been grown in Mexico since the 19th century (Bobrow-Strain 2007). Initially, Mexican peasants worked as hired labor on large coffee plantations. In the early 20th century, as a result of the land redistribution of the 1917 Mexican Constitution, these smallholder producers received their own plots of land, nearly all of which were less than 5 hectares.

Green coffee is only the first stage in the coffee value chain. Figure 1 provides a high-level overview of the entire coffee value chain. A smallholder producer sells to a local intermediary (either a village trader or in our case, a coffee cooperative). This local intermediary in turn sells to a national intermediary. Finally, that national intermediary sells to a multinational corporation.

Smallholder coffee producers face substantial output price volatility at the first level of the value chain. Because of this output price volatility, they do not produce an optimal amount of coffee. In addition, they do not make long-term investments in coffee production through quality upgrading that would allow them to increase the income they receive from coffee production.

2.2 | State-Led Development for Mexican Coffee Producers

The past 100 years have seen two different approaches to improve the welfare that smallholder coffee producers receive from their harvest: state-led and market-led development. In the first approach, state actors provided increased support for smallholder coffee producers as coffee production developed in Mexico through the early and middle of the 20th century. At the international level, in 1962 the coffee producing nations of

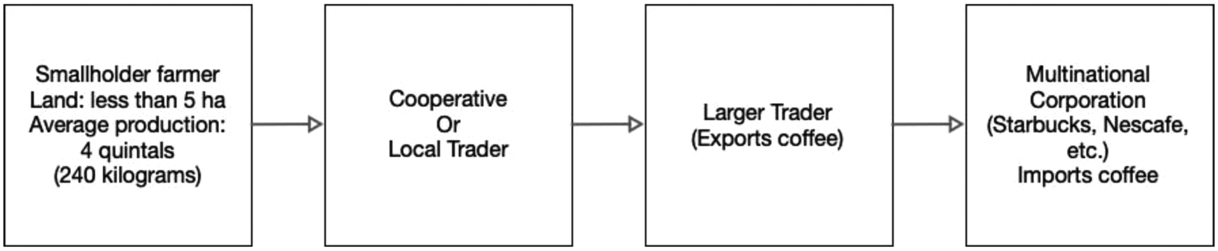

FIGURE 1 | Coffee value chain.

the world formed the International Coffee Organization (ICO) in order to stabilize the world market for coffee after a series of boom-bust cycles. With the establishment of the ICO, the International Coffee Agreement (ICA) used periodically renewed export quotas to stabilize the international price of coffee. This agreement lasted until 1994.

At the national level, in 1973 the Mexican government founded a state agency to support coffee producers, the Mexican Coffee Institute (Renard and Breña 2010). This agency provided direct support to coffee producers: subsidized inputs, technical assistance, and a guaranteed purchase price. In turn, it helped Mexican coffee producers sell their coffee internationally for almost 20 years.

The life cycle of the Mexican Coffee Institute overlapped with the external debt crisis faced by Mexico and other Latin American countries during the 1980s. As part of the Baker Reforms in 1986, Mexico agreed to reduce the level of agricultural support for domestic producers in order to receive international financing to cover its external debt. As a result, beginning in 1990, the administration of Mexican president Carlos Salinas phased out the Mexican Coffee Institute as it implemented a larger series of market-based reforms. Since then, Mexican smallholder coffee producers have been exposed to the international price of green coffee as it is traded on commodity markets like the New York Mercantile Exchange. Figure 2 shows the price per kg of green Arabica coffee in US cents from 1990 to the present.

2.3 | Market-Led Development for Mexican Coffee Producers

With the elimination of the Mexican Coffee Institute, producer cooperatives emerged in Mexico in the 1990s that provide the same services to smallholder producers: a guaranteed purchase price, technical assistance, and microcredit (Folch and Planas 2019). These cooperatives are often associated with the fair-trade movement (Dragusanu et al. 2014). In addition, they frequently promote organic farming practices. Typically, members have three years from joining the cooperative to adopt organic farming practices.

Producer cooperatives improve the welfare of their producer members by taking advantage of upstream contracts in the value chain. These contracts help in two ways. First, they allow cooperatives to offer a fixed price to their members, in contrast to the volatile price of the commodity market. Second, they spread the fixed marketing costs faced by smallholders over a larger marketed volume to reduce the cost per unit of marketing. Cooperatives use these savings to finance complementary services, such as microcredit and technical assistance. However, the effectiveness of cooperatives depends on a guaranteed volume of deliveries from members. As a condition of membership, these cooperatives often require that their members sell all their coffee through the cooperative. When members sell their coffee to outside buyers, it threatens the financial viability of the cooperative.

2.4 | Our Partner Cooperative: Ts'umbal Xitalha'

Producer cooperatives provide a variety of services and operate in a variety of ways, so we describe the particular way our partner cooperative operates and the particular services it provides.

The producer cooperative Ts'umbal Xitalha' (TX) has existed since 2000. It has evolved to provide price insurance, emergency loans, and technical assistance to its producer members. In October, at the beginning of each marketing year, the executive board of the cooperative sets the purchase price for the coming year. The TX members agree to deliver their coffee to the cooperative during the harvest season. Unlike other cooperatives, which pay their members at the end of the marketing year, TX pays on delivery. Local intermediaries or traders are also active in the region. They buy coffee at the world price, which varies daily, as Figure 2 indicates, plus a small markup of MXN 5 to MXN 10 (US$0.50 to US$1.00). Although TX stipulates that its members market their entire coffee harvest through the cooperative, it cannot enforce this requirement. Thus, when local traders offer a higher price than TX, members face the temptation to market some or all of their coffee harvest through these local traders instead of the cooperative.

Figure 3 shows the TX price and the world price for the marketing years 2019–2025. Figure 4 summarizes TX administrative data to show the number of members who delivered their coffee to TX in each marketing year and the total volume of coffee that these members delivered.

In the marketing year after the pandemic, the world price of coffee (and thus the price offered by local traders) increased above the price offered by TX for an extended period of time. This situation emerged for two reasons. First, a decrease in demand among TX's customers left it with excess inventory and reduced the price it could offer the following year. Second, higher transaction costs and labor issues across the worldwide coffee industry caused an increase in the world price of coffee and thus the price offered by local intermediaries.

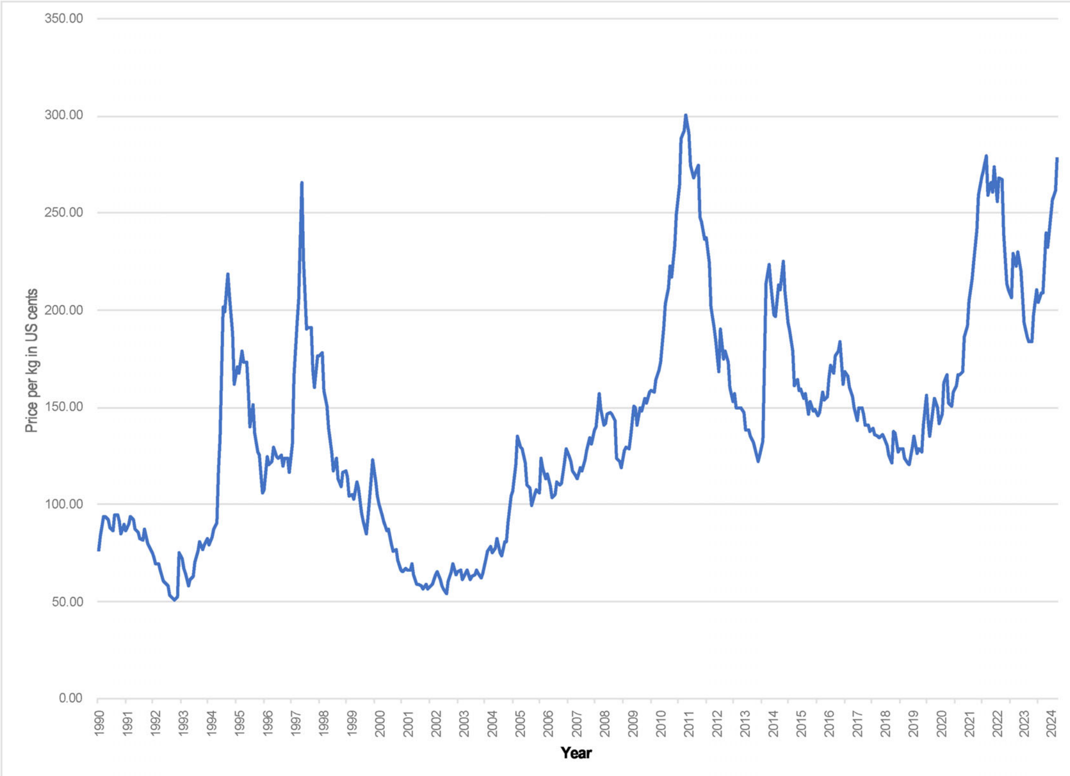

FIGURE 2 | World price of Arabica coffee. *Source:* International Monetary Fund, Global price of Coffee, Other Mild Arabica [PCOFFOTMUSDM], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/PCOFFOTMUSDM, May 28, 2025.

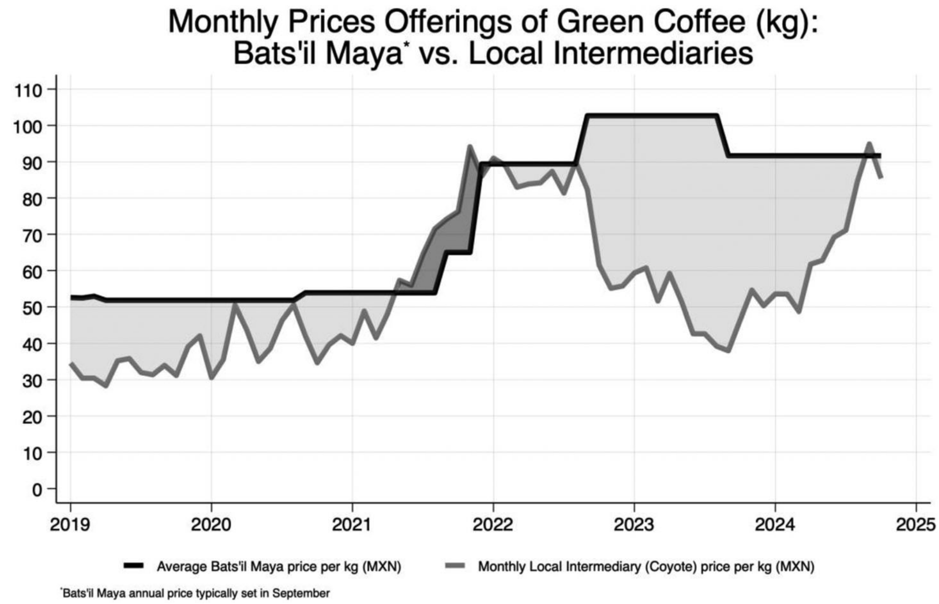

FIGURE 3 | Coffee cooperative versus local trader price (2019–2024). *Source*: Administrative data from Ts'umbal Xitalha' Coffee Cooperative.

As a result, member coffee deliveries to TX decreased by half during 2021 and 2022, a phenomenon that affected the viability of TX. Figure 5 shows that more of the decline occurred at the intensive margin than at the extensive margin. Although the total number of members who delivered any of their coffee harvest to TX decreased, many members continued to deliver some of their coffee harvest to the cooperative, but substantially reduced the size of their deliveries. Because members do not disclose the total amount of their coffee harvest to TX, TX cannot know whether members are side-selling or how much they are side-selling.

In order to continue serving its members, TX sought external financing to increase the price it could offer its members. As Figure 4 indicates, by 2023, the world price of coffee decreased, so TX members no longer faced the temptation to side-sell. However, TX partnered with us to understand more deeply the causes of

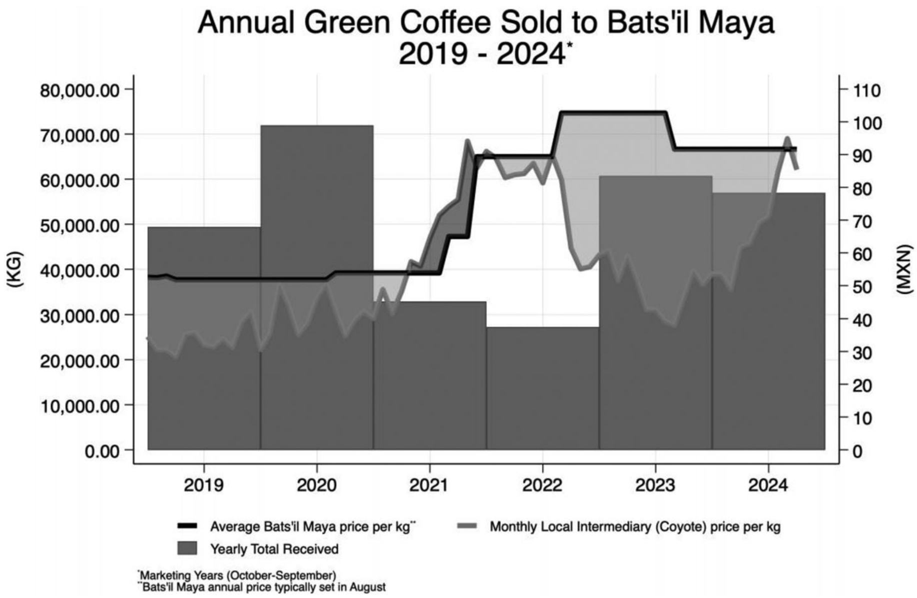

FIGURE 4 | Coffee deliveries and market prices (2019–2024). *Source*: Administrative data from Ts'umbal Xitalha' Coffee Cooperative.

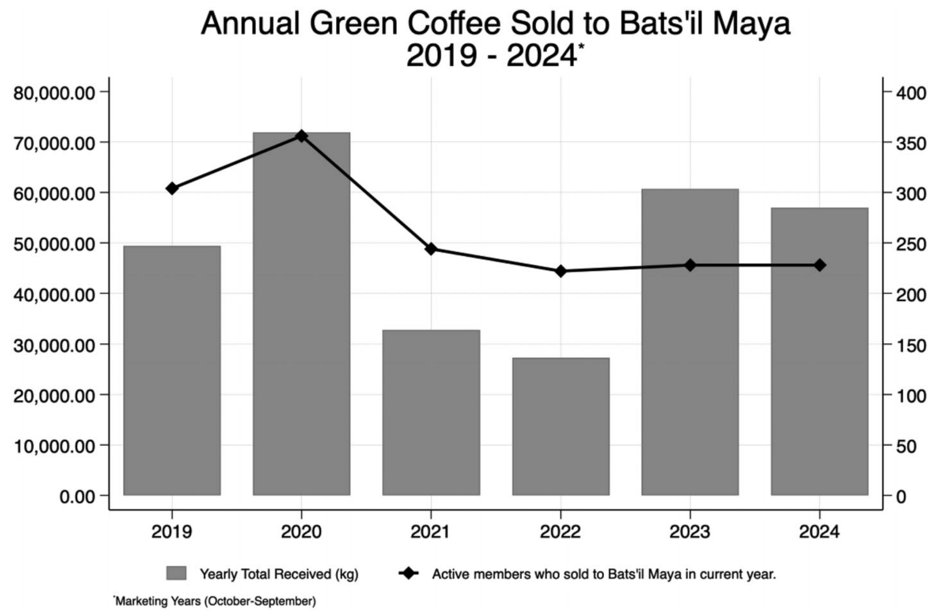

FIGURE 5 | Coffee deliveries and members (2019-2024). *Source*: Administrative data from Ts'umbal Xitalha' Coffee Cooperative.

side-selling behavior and explore potential policy responses to prepare for a possible future scenario in which the world price of coffee could once again exceed the price offered by TX.

3 | Experimental Design

3.1 | Experiment Overview

In this section, we describe our experimental protocol that examines coffee producers' marketing decisions. We present participants with a simplified version of the marketing decision they face in real-life, which we described in Section 2. Within the taxonomy of field experiments, our experiment is a framed field experiment (Harrison and List 2004) or a lab-in-the-field experiment (Eckel and Londono 2021) because we invite members of the target population to replicate a concrete task that they perform in their daily lives. We simplify the decision in four ways to better understand the core mechanism at work.

1. Ideally, any side-selling by members would be punished by expulsion from the cooperative. Thus, the cooperative would be able to force its members to always deliver their entire harvest to the cooperative. This sort of punishment is infeasible for two reasons:

   a. First, in this region, as in many regions with a substantial population of smallholder producers, nearly all of the cooperative members have social ties that stretch back for generations. Punishing members who side-sell would negatively affect these ties in ways that would spill over to religious, cultural, or other economic interactions.

b. Second, the cooperative does not record the total harvest of members, so it cannot verify the fraction of members' harvest that they are marketing through the cooperative. For this reason, we model side-selling as an isolated decision that producer members make independently each year.

2. Many estimates of side-selling in the literature come from contexts with variation in the timing of payment. Smallholder producers may choose between a local trader that pays them immediately and a cooperative that pays them at the end of the growing season. In this case, a producer's time preferences would influence the decision to side-sell. To eliminate this potential confounder, in our experiment participants are paid immediately by both the certain-price and the uncertain-price buyer

3. The presence of transaction costs also varies depending on the context. In some contexts, producers who side-sell to a local trader incur a fixed cost compared to selling to the cooperative. In other contexts, producers who sell to the cooperative incur a fixed cost compared to selling to the local trader. To consider both situations, we vary the mean of the price offered by the uncertain-price buyer as either above, below, or the same as price offered by the certain-price buyer. These three options correspond to contexts where there is a fixed cost to side-selling, no fixed cost to either marketing decision, or a fixed cost to selling to the cooperative.

4. Finally, institutional arrangements with respect to complementary services vary tremendously. In some contexts, local traders provide microcredit and possibly even technical assistance. In other contexts, only cooperatives provide these services. In addition, institutional arrangements vary in terms of eligibility for either of these services. The strictest possible arrangement would restrict complementary services to cooperative members. Spillover effects among neighbors, some of whom are cooperative members and others who are not, often prevent the enforcement of this sort of restriction. Thus, we provide nudge reminders to test for the effect of the provision of these services.

   Nudge reminders are often used in food economics to persuade consumers to make healthier food choices (Caputo and Just 2022). For example, choosing healthier food or smaller portions will benefit consumers in the medium to long run. Instead of coercing consumers (a paternalistic approach), researchers have tried to randomly vary the labeling of foods or provide additional information on menus as a way to induce consumers to voluntarily make healthier choices.

   Depending on the context, these types of interventions can have a moderate effect, especially if they are directly relevant (salient) to the consumer. We approach a participant's marketing decision in a similar way, testing the effect of changing the description of the certain-price buyer on the participant's allocation decision. We incorporate salience into our descriptions: for example, we describe the certain-price buyer specifically as a buyer that "provided you (the participant) with microcredit in the past year" instead of generically as a buyer "who provides microcredit." These nudge reminders allow us to separately evaluate the appeal of the three services that cooperatives and other traders most commonly provide: price insurance, microcredit, and technical assistance.

   By examining the effect (if any) of the nudge reminders on the allocation decision, we hope to estimate the participant's willingness to pay for these additional services. Moreover, using nudge reminders allows us to separate the potential service itself from the intermediary (cooperative or local trader) who provides it. For example, in the second game, we add microcredit to the description of the certain-price buyer but do not describe it as a cooperative provides it. In this way, our aim is to estimate separately participants' willingness to pay for microcredit and their preference for a cooperative.

In the experiment, participants market their coffee 60 times in three games of 20 rounds apiece. During these 60 rounds, we vary four factors to determine their effect on the marketing decision.

1. Half of the participants receive **additional income** at the beginning of the experiment that increases their earnings in each round of the three games they play.
2. In blocks of 20 rounds, we vary the **framing** of the certain-price buyer as a buyer who offers a certain price (Game 1); a certain price and microcredit (Game 2); a certain price, microcredit, and technical assistance (Game 3). All participants play all three games in random order.
3. By round, we vary the **harvest size of the participants, the mean of the price offered by the uncertain-price buyer**, and **the realized price of the uncertain-price buyer**.

In the subsequent sections, we describe each part of the experiment conceptually in detail: both the antecedents in the literature and the practical details in our experiment. In Section 4, we introduce the notation for the different pieces of the experiment and provide the payoff function. Appendix A gives the complete experimental protocol.

3.2 | Preliminary Questions

Participants first answer two basic questions and three arithmetic and probability questions. We use questions similar to those in Boyd and Bellemare (2022).

Basic Questions

1. Have you ever sold coffee you or your family has produced?
2. Do you know how to read and write? Yes/No

Filter Questions

1. What is 40% of MXN 100?
2. If you produce 17 bags of coffee and sell 9, how many remain?
3. Imagine that there are 3 blue balls and 7 red balls. You pick a ball at random. Is it more probable that it is red or blue?

TABLE 1 | Descriptive statistics at the participant level.

N		Yes	No	Mean	SD
Exit survey					
Gender (1 = Female)	268	131	137	0.489	0.501
Age	268	—	—	43.593	15.587
Completed only middle school (1 = Yes)	268	37	231	0.138	0.346
Completed high school (1 = Yes)	268	29	239	0.108	0.311
Administrative data					
Cooperative member (1 = Yes)	268	126	142	0.470	0.500
Years sold to cooperative	124	—	—	9.347	2.509
Preliminary activities					
Can read/write (1 = Yes)	268	199	69	0.743	0.438
Understands arithmetic (1 = Yes)	268	268	0	1.000	0.000
Understands percentages (1 = Yes)	268	266	2	0.993	0.086
Understands probability (1 = Yes)	268	200	68	0.746	0.436
Additional income treatment (1 = Yes)	268	134	134	0.500	0.501
CRRA (from Eckel–Grossman lottery)	268	—	—	0.530	0.655
Practice game (1 = Yes)	268	228	40	0.851	0.357
Outcome of interest					
Overall margin	268	—	—	0.821	0.221
Extensive margin	268	58	210	0.216	0.413
Intensive margin	210	—	—	0.772	0.225

Notes: Forty participants did not complete the practice game because of enumerator error. Overall margin is average allocation to certain-price buyer across 60 rounds. Extensive margin is 1 if a participant always allocates entire harvest to certain-price buyer across 60 rounds, 0 otherwise. Intensive margin is the average allocation for the subset of participants for whom extensive margin is not 1.

Descriptive statistics of the responses to four out of five of these questions are reported in Table 1. All participants report experience selling coffee, so we omit these responses. 74% of participants report some literacy.

The second set of questions allows us to determine whether side-selling behavior is associated with poor multiplication, subtraction, or probability skills. Originally, we intended to exclude (filter) participants who missed more than one of the questions. This criterion would have disqualified two of the participants. However, based on the guidance of our implementing partner, we did not exclude any participants.

Next, the order in which the three games and the lottery are played is randomized by a roll of a 12-sided die. Table 2 shows the results of this randomization. Half of the participants complete the lottery before the three games, and the other half complete it after the three games.

3.3 | Additional Income Treatment

Next, half of the participants receive MXN 3000 (US$150) in fake money that serves as additional income in each round of the three games and contributes to their overall earnings. The treated participants are selected based on their identification number within the sample: participants with odd numbers receive the additional income and participants with even numbers do not receive the additional income.

The additional income is meant to proxy for the real-world effect of income from another source such as the sale of another cash crop, income from off-farm labor, or support from a Mexican government program. We choose an amount (MXN 3000) that is about half of what producers could conceivably earn from these sources in a month.

1. **Another cash crop**. The main alternative cash crop in the region is honey. According to records from a honey cooperative in the region, producer members earned on average MXN 20000 (US$1000) from honey sales during the three and a half months of the honey season the year before the experiment, or just under MXN 6000 (US$300) per month.
2. **Income from off-farm labor**. Similarly, weekly pay is MXN 1500 (US$150) in manufacturing plants on the US/Mexico border, where many producers report migrating seasonally. With 1–2 months of work, minus expenses, a producer could earn about MXN 6000 (US$300).
3. **Support from a Mexican government program**. Finally, participants in this region are eligible for a Mexican government agricultural support program (Sembrando Vida), in which smallholder producers can earn up to MXN 6000

TABLE 2 | Game order.

	Order	Count
Lottery before		
	Lottery, Game 1, Game 2, Game 3	26
	Lottery, Game 1, Game 3, Game 2	26
	Lottery, Game 2, Game 1, Game 3	22
	Lottery, Game 2, Game 3, Game 1	24
	Lottery, Game 3, Game 1, Game 2	24
	Lottery, Game 3, Game 2, Game 1	20
Subtotal	—	142
Lottery after		
	Game 1, Game 2, Game 3, Lottery	19
	Game 1, Game 3, Game 2, Lottery	25
	Game 2, Game 1, Game 3, Lottery	15
	Game 2, Game 3, Game 1, Lottery	23
	Game 3, Game 1, Game 2, Lottery	23
	Game 3, Game 2, Game 1, Lottery	21
Subtotal	—	126
Total	—	268

Notes: All participants completed three games and an Eckel–Grossman risk preference lottery before or after the three games. The order of the lottery and the games was determined with a roll of a 12-sided die.

(US$300) per month by planting trees on their land parcels (Reglas de Operación Del Programa Sembrando Vida 2022).

Randomly assigning this treatment allows us to determine the effect of additional income on the marketing decisions of the participants who receive it. Previous work examines the effect of additional income on production decisions of cash crops (Pfeiffer et al. 2009) or marketing decisions of staple goods (Woldeyohanes et al. 2017). Pfeiffer et al. (2009) find that additional income causes producers to increase production in the presence of a credit market failure because they use it to finance the purchase of production inputs. Woldeyohanes et al. (2017) find that producers market less of staple goods in the presence of off-farm income in order to keep a food reserve and insure consumption. Our experiment does not allow participants to store coffee across years.

The closest study to the present is that of Wollni and Fischer (2015), who hypothesize that non-agricultural income will increase member deliveries to cooperatives. In their model, however, cooperatives deliver patronage refunds at the end of the marketing year, so the non-agricultural income merely allows for consumption smoothing across time periods.[6] In our context, any effect of the additional income will indicate deviation from purely profit-maximizing behavior. To our knowledge, we are the first to experimentally test the effect of additional income on the marketing decision of a cash crop.

3.4 | Eckel–Grossman Lottery

Next participants complete an Eckel–Grossman lottery to measure their risk preferences. Eckel and Grossman (2008) propose a simple task for measuring risk preferences similar to that of Binswanger (1980). Participants choose one of five gambles, each with a low payoff and a high payoff that occur with 50% probability. The gambles are increasing in both expected payoff and risk, as measured by the standard deviation between the two payoffs. After participants choose their preferred gamble, they roll a die and receive the corresponding payoff.

An advantage of the Eckel–Grossman lottery compared to other lotteries such as that of Holt and Laury (2002) is its simplicity (Charness et al. 2013). This simplicity allows its use in other settings in Latin America with a population similar to our indigenous coffee growers (Cardenas and Carpenter 2013; Moya 2018). Moreover, despite its simplicity, the participant's choice of gamble can be used to estimate his or her risk preferences in the form of a constant relative risk aversion (CRRA) parameter of the power utility function $U(x) = x^{(1-r)}/(1-r)$.

Table 3 shows the Eckel–Grossman lottery that we present to our participants. Eckel and Grossman (2008) provide two sets of gambles: one with negative payoffs (to test for loss aversion) and one without. For simplicity, we use the no-loss lottery and scale the payoffs ($16 = MXN 10000 or US$500) so that the first gamble has a guaranteed payoff of MXN 10000 MXN. We choose MXN 10000 because it is the average payoff in a round of the game (4 quintals · 60 kg per quintal · MXN 50/kg = MXN 10,000).

3.5 | The Presence of Complementary Services

After the preliminary activities, participants complete 10 rounds of Game 1 for practice. The results of this practice game are not recorded.[7] Next they complete Games 1–3 in random order. Game 2 and Game 3 vary the framing of the certain-price buyer by describing up to two complementary services that the participant received last year from the buyer. In addition, in Game 3, the certain- price buyer is described as a cooperative.

Game 1: Certain-price buyer offers a fixed price of MXN 50/kg.

Game 2: Certain-price buyer offers a fixed price of MXN 50/kg **and gave the participant microcredit in the past year**.

Game 3: A cooperative offers a fixed price of MXN 50/kg **and gave the participant microcredit and technical assistance last year**.

As Section 2 describes, microcredit and technical assistance are provided by TX, the cooperative that operates in this region. The welfare-enhancing effects of both services are confirmed by a recent systematic review (Liverpool-Tasie et al. 2020). However, supplying these services imposes additional costs on the cooperative that lower the guaranteed minimum price it can offer members for their coffee. Moreover, not only the cooperative but also local traders can provide fixed prices and complementary services. Here, we are interested in whether participants value these services enough to market at least a fraction of their coffee through a buyer that offers these services even if they could earn more by marketing it through a buyer that does not.

In all three games, the certain-price buyer provides a fixed price. Thus, the allocation decision tests the participant's preference

TABLE 3 | Gamble choices, expected payoff, and risk.[a]

Choice	Event	Probability (%)	Payment (MXN)	Expected payoff	Risk[b]	CRRA[c]
1	A	50%	10000	10000	0	$r > 2$
	B	50%	10000			
2	A	50%	15000	11250	3750	$0.67 < r < 2$
	B	50%	7500			
3	A	50%	20000	12500	7500	$0.38 < r < 0.67$
	B	50%	5000			
4	A	50%	25000	13750	11250	$0.20 < r < 0.38$
	B	50%	2500			
5	A	50%	30000	15000	15000	$r < 0.20$
	B	50%	0			

[a] Adapted from Table 1 in Eckel and Grossman (2008).
[b] Measured as standard deviation of expected payoff.
[c] Calculated as the range of r in the function $U(x) = x^{1-r}/(1-r)$ for which the subject chooses each gamble assuming constant relative risk aversion utility.

for price certainty. In the second game, the certain-price buyer is described as a buyer who provided the participant with microcredit in the past year. This buyer could be a trader or a cooperative; the game does not specify. Rather, by comparing the participant's preference for the second over the first framing of the certain-price buyer, we hope to estimate the participant's willingness-to-pay for microcredit. Only in the third game is the certain-price buyer described as a cooperative that provides microcredit and technical assistance. By comparing the participant's preference for the third over the second framing of the certain-price buyer, we hope to estimate the participant's willingness-to-pray for technical assistance provided by a cooperative.[8]

3.6 | Harvest Quantity

Each round of the experiment corresponds to a marketing year. At the beginning of the round, the participant's harvest quantity for that year is determined randomly by the roll of a 12-sided die. Each of the four possibilities for the harvest quantity—2, 4, 6, or 8 quintals—appears with the same probability (25%).[9] Once the harvest quantity is realized, participants receive a corresponding number of miniature burlap bags.

Under a profit-maximizing framework, harvest quantity should not impact the marketing decision. Profit-maximizing participants should sell their entire harvest to the buyer who gives them the best price. However, previous studies indicate that harvest quantity affects the marketing decision; moreover, they find that it affects the decision differently for poor producers and rich producers.

Fafchamps and Hill (2005) examine the decision to sell coffee at the farmgate or market by Ugandan coffee producers. They find a U-shaped relationship: the very poor and very rich are more likely to sell at the farmgate, because of lack of transportation to the market for the former and the higher opportunity cost of time for the trip to the market for the latter.

Wollni and Fischer (2015) examine determinants of how producers allocate their coffee harvest among two buyers. They also find a U-shaped relationship between farm size and coffee deliveries. Initially, the relative profitability of marketing to outside buyers increases with farm size, and producers with medium-sized farms sell more to outside buyers than producers with smaller farms. However, as farm size continues to increase, however, producers' discount rate of patronage refunds decreases as well. The reason is that producers with larger farms have more access to other sources of income than producers with medium-sized farms to insure their consumption and deal with unexpected expenses. Thus, producers with larger farmers sell a smaller share of their harvest to outside buyers than producers with medium-sized farms. Based on this previous work, we expect to find a U-shaped relationship between harvest quantity and producer marketing decisions.

3.7 | Certain-Price Buyer Versus Uncertain-Price Buyer

In each round, participants allocate their harvest between a certain-price and an uncertain-price buyer. The certain-price buyer always offers them MXN 50 (US$2.50)/kg for their coffee. The description of the certain-price buyer varies according to the presence of complementary services above. The uncertain-price buyer offers them a price whose mean varies: below the certain price MXN 45 (US$2.25)/kg, the same as the certain price MXN 50 (US$2.50)/kg, or above the certain price MXN 55 (US$2.75)/kg. The price follows a multinomial distribution with five supports that is constructed to approximate a normal distribution. Figure 6 shows the three possible distributions. In each distribution, the mean appears four times, the two values MXN 5/kg above and below the mean appear three times, and the values MXN 10/kg above and below the mean appear once.

Constructing the distribution in this way allows the roll of a 12-sided die to approximate a draw from a normal distribution.

Crucially, participants allocate their coffee harvest after learning the mean of the price of uncertain-price buyer (in other words, which of the three distributions the realized price will follow) but before learning the realized price. Next, they allocate their coffee harvest between the two buyers in increments of 1 quintal. To aid them in the allocation decision, a payoff table is shown that gives the revenue from all possible allocations conditional on the coffee harvest and distribution of the uncertain-price buyer in the current round. They must allocate the entire harvest and cannot store coffee for subsequent rounds. Figure 7 gives a representative table.[10]

Conditional on the mean of the uncertain-price buyer, expected utility theory predicts the behavior of a risk-neutral participant as follows.

1. **Uncertain-price buyer mean of MXN 45/kg**. Allocate the entire harvest to the certain-price buyer.
2. **Uncertain-price buyer mean of MXN 50/kg**. Be indifferent between the certain-price buyer and uncertain-price buyer.
3. **Uncertain-price buyer mean of MXN 55/kg**. Allocate the entire harvest to the uncertain-price buyer.

Notably, in all three scenarios, depending on the realization of the price of the uncertain-price buyer, participants could potentially make more revenue by allocating some or all of their harvest to the uncertain-price buyer.

In practice, participants are not risk neutral. They are risk averse but vary in the degree of risk aversion. Thus, we can use their allocation decisions to recover their risk preferences as follows. Examining allocation decisions in the situation where the mean of the uncertain-price buyer is MXN 50/kg, the same price offered by the certain-price buyer, allows us to determine participants' preferences for price certainty. Adding the other two possibilities for the uncertain-price buyer (i.e., mean MXN 5/kg higher or MXN 5/kg lower than the price offered by the certain-price buyer) allows for the estimation of the effect of small changes in the market environment on participants' allocation decisions. As we pointed out above, these slight variations in price could reflect differences in transaction costs or daily variation in the world price of coffee.

After the allocation decision, participants learn the realized price of the uncertain-price buyer and their revenue for the round. This revenue is added to their running total for the experiment. If they are in the treatment group for the additional income, then this income is added as well at the end of each round.

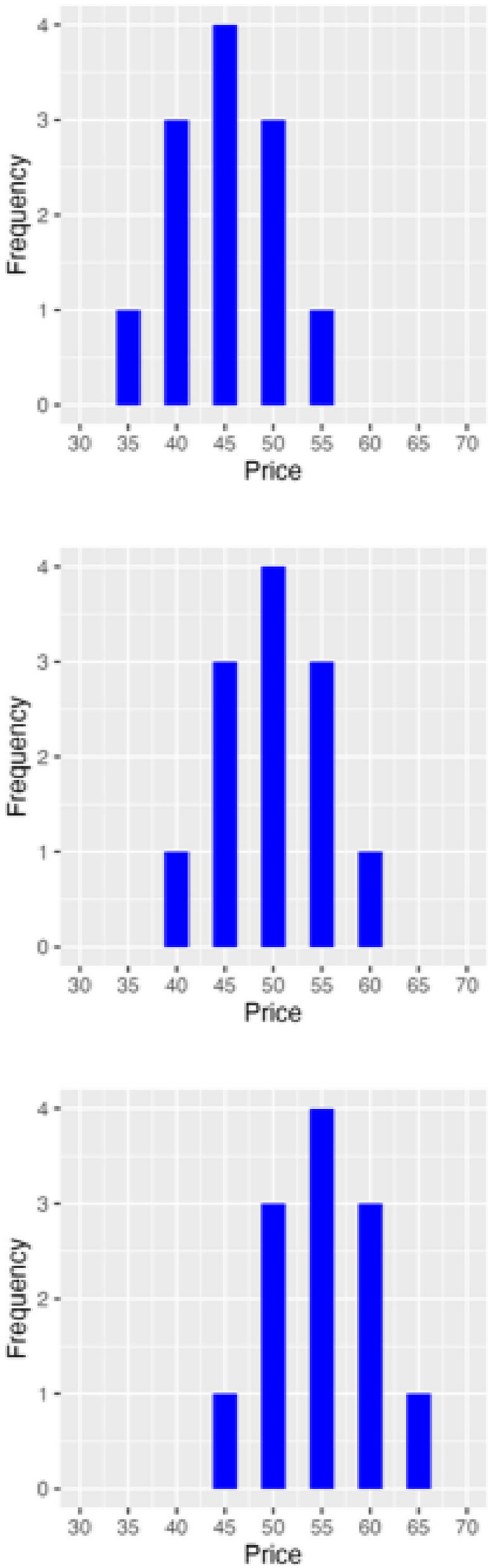

FIGURE 6 | Uncertain-price buyer distributions. This figure shows the three possible distributions of the price offered by the uncertain-price buyer. All three distributions are multinomial distributions with five support points that approximate a normal distribution. The three distributions have mean values of MXN 45, MXN 50, and MXN 55. In each distribution, the mean appears 4 times, support points MXN 5 above or below the mean appear three times, and support points MXN 10 above or below the mean appear once.

3.8 | Final Activities

Recall that we randomly assigned half of the participants to complete the Eckel–Grossman lottery before the three games and half to complete it after the three games. The half of the participants who did not complete it before complete it now. All participants complete an exit survey with information about their household and agricultural production.[11]

Quintals Sold to Certain Price Buyer (60kg)								
0	1	2	3	4	5	6	7	8
Quintals Sold to Uncertain Price Buyer (60kg)								
8	7	6	5	4	3	2	1	0

Total Revenue from Sales to Both Buyers

	Revenue from Sale to Certain Buyer: (Quantity sold to Certain Buyer x $50 MXN)								
	0	3,000	6,000	9,000	12,000	15,000	18,000	21,000	24,000
Price per kg. (MXN)	Revenue from Sale to Uncertain Buyer: (Quantity sold to Uncertain Buyer x Dice Result)								
40	19,200	16,800	14,400	12,000	9,600	7,200	4,800	2,400	0
45	21,600	18,900	16,200	13,500	10,800	8,100	5,400	2,700	0
50	24,000	21,000	18,000	15,000	12,000	9,000	6,000	3,000	0
55	26,400	23,100	19,800	16,500	13,200	9,900	6,600	3,300	0
60	28,800	25,200	21,600	18,000	14,400	10,800	7,200	3,600	0

FIGURE 7 | Representative payoff table. Participants are shown one of 12 tables of this form each round to aid them in their decision of how much of their harvest to allocate to the certain-price buyer. The tables vary according to the harvest quantity and mean price offered by the uncertain-price buyer. Appendix A contains all 12 tables.

3.9 | Compensation

We compensate participants based on their performance in the experiment. On the advice of our implementing partner, we do not make cash payments to participants. In this way, we differentiate ourselves from the representatives of the Mexican government who distribute various support programs either directly in cash or via direct deposit. Rather, we provide vouchers redeemable on site for dry goods: a bottle of cooking oil, laundry detergent, a bag of sugar, a bag of salt, or a bag of rice. Each voucher corresponds to earnings of MXN 250,000 in the game. Participants can earn between three and six vouchers.

A potential concern is that participants who are assigned the additional income treatment could receive more compensation than those who are in the control group. Recall that treated participants receive MXN 3000 additional income per round or MXN 180,000 of additional income over 60 rounds. At most, they receive one voucher more compared to a counterfactual scenario with identical performance in the game but without the treatment. Thus, we argue that the possible compensation is nearly the same for treatment and control participants and thus treatment assignment does not affect participants' behavior in the game.

This compensation satisfies the three criteria proposed by Eckel and Londono (2021). It is *monotonic* because participants who perform better in the game receive more compensation. It is *salient* because participants understand how their actions in the experiment translate into their level of compensation. It is *dominant* because the market value of these products corresponds to the opportunity cost of a day's wages that participants give up to participate in the game.

4 | Data and Descriptive Statistics

4.1 | Sample Selection

Data come from a framed field experiment that we conducted with 268 indigenous coffee producers in northeast Chiapas, Mexico, in summer 2022. During this period, we scheduled 11 field visits to eight of the ten regional centers in the area served by the Ts'umbal Xitalha' (TX) coffee cooperative. For logistical reasons, we were unable to visit two of the regional centers. The field visit dates were announced and arranged through local churches and community centers, so cooperative members and non-members were equally aware of the opportunity to participate. At three regional centers, more participants volunteered than we could accommodate in a single day, so we returned for a second day to those sites to accommodate all participants. After all field visits were completed, we used the TX member list to determine which participants came from families that marketed their coffee through the cooperative and classified them accordingly. Table 4 gives an overview of the field visits and a breakdown of the number of cooperative members and non-members who participated in the experiment at each regional center.

We briefly discuss the external validity of the study. The external validity of our study refers to the extent to which the results are representative of those of the population under study, indigenous coffee producers. One potential threat to the external validity of

TABLE 4 | Field visits to regional centers served by Ts'umbal Xitalha'.

	Dates	Participants		
		Non-members	Members	Total
Agua Dulce Tehuacan	July 15	9	12	21
Chilón	N/A	—	—	—
Coquilte'el	July 20	13	12	25
Nuevo Progreso	Aug 3; Aug 22	45	10	55
Paraiso Chic'otanil	July 14	4	21	25
San Jose Veracruz	June 29; Aug 2	18	29	47
Tzubute'el	July 19	6	20	26
Yaxwinic	June 30; July 1	45	16	61
Ye'tal Ts'ahc	N/A	—	—	—
Yochibha	June 28	2	6	8
Total	—	142	126	268

Notes: Field visits were conducted in summer 2022. For logistical reasons, we could not visit two of the ten regional centers. After all of the field visits were completed, we used the TX member list to determine whether experiment participants were in cooperative member families.

our study could be selection bias. For example, Frijters et al. (2015) found selection bias in an artefactual field experiment in rural China. We argue that our sample does not suffer from selection bias for the following reasons:

1. Any coffee producer can participate in the experiment. We do not allow more than one individual from the same family to participate in the study due to the limited amount of dry goods we bring on the field visits for compensation.
2. Participation is not associated with on-farm economic opportunities. We conducted the experiments in the summer between the planting season and the harvest season. The coffee harvest of participants would not be affected if they neglected it for 1 day to participate in the experiment. Similarly, it is unlikely that their neighbors would ask them for their help with their coffee fields on the day of the field visit. Thus, there is no social or financial opportunity cost to participating in the experiment.
3. Participation is not associated with off-farm economic opportunities. Although some indigenous people in this region internally migrate to work off-farm in the summer months, whole families do not. Thus, if one member of a family is away pursuing off-farm work, then a family can send another member to participate. In fact, some did.
4. Our sample of 268 producers is larger than the sample for similar experiments. It is slightly larger than that of Binswanger (1980), who surveyed 240 Indian smallholder producers, and it is considerably larger than that of Mattos and Zinn (2016), who surveyed 75 grain producers in Manitoba; the sample of Bellemare et al. (2020), who surveyed a combination of 119 US undergraduates and Peruvian potato farmers; and the sample of Boyd and Bellemare (2022), who surveyed 101 Peruvian potato farmers.

The external validity of our study also refers to the degree to which our results generalize to other populations. As we describe in Section 2, this population of coffee producers is demographically representative of smallholder coffee producers in other places. In addition, with the breakdown of the International Coffee Agreement, cooperatives similar to our partner cooperative have emerged in coffee-producing regions around the world. Like our partner cooperative, these cooperatives struggle to compete with local traders as they provide value-added services such as microcredit and technical assistance. Due to weak institutional arrangements, they also struggle with side-selling. Moreover, as we describe in the Introduction, the issue of side-selling extends beyond coffee to any number of other cash crops that smallholder producers' market through agricultural producer cooperatives. We argue that our study also sheds light on the causes of side-selling in these contexts.

4.2 | Descriptive Statistics at the Participant Level

Table 1 presents summary statistics at the participant level. The first group of characteristics comes from the exit survey that participants complete after the experiment. The sample has slightly more men than women. The mean age of the participants is 44 years with a standard deviation of 16 years.

There are slightly less women ($n = 131$) than men ($n = 137$). In addition to gender, we also report on the educational level of participants. Mexico requires 9 years of compulsory education: six of primary school and three of secondary school. Most of the participants (75%) report only a primary school education. 14% report only a middle school (secondary school) education. 11% have also completed high school (preparatory school). All participants speak an indigenous language (Tseltal) as their first language and learn Spanish as their second language starting at primary school.

The second group of characteristics comes from administrative data from the cooperative. As we mentioned above, after completing all field visits, we matched participant names to the TX member list to label 126 participants as cooperative members. For 124 of these members, the cooperative could provide us with the number of years in the period 2013–2024 that these members delivered coffee to the cooperative. We use this value to measure members' loyalty to the cooperative. Figure 11 displays a histogram of these values.

The third group of characteristics comes from the preliminary activities: filter questions, treatment assignment, and lottery. Participants answer five preliminary questions before participating in the experiment to assess their understanding of basic mathematical concepts. Section 3.2 gives more information. All participants grow coffee and 74% report being able to read and write. All 268 correctly answer the arithmetic question, 266 correctly answer the percentage question, and 200 correctly answer the probability question. After the preliminary questions, they are randomly assigned MXN 3000 additional non-farm income. We see an equal number of treatment ($n = 134$) and control ($n = 134$) participants.

In the main part of the experiment, participants complete the practice game and three games of 20 rounds apiece. The games differ in how they frame the certain-price buyer. Section 3.5 gives more information. We randomize game order and lottery placement using a 12-sided die. Table 2 shows the results of this randomization. Both lottery placement and the order of the games are approximately randomized.

4.3 | Eckel–Grossman Lottery

Participants complete an Eckel–Grossman risk preference elicitation lottery before or after the practice rounds and three games. Section 3.4 gives more information. Figure 8 shows gamble choices of participants broken down by gender. In our results, men and women show the same preferences with the highest preference for gamble 5. These results differ from those of Eckel and Grossman (2008), who find gender differences in lottery preferences. In their results, men's preferences are right-skewed with the highest preference for gamble 5, and women's preferences follow a normal distribution with the highest preference for gamble 3. Figure 9 shows gamble choices of participants broken down by cooperative membership status. As we discuss in Section 6, cooperative members are slightly more risk averse than cooperative non-members. Figure 10 shows the gamble choices of the participants broken down by lottery position. There does not appear to be an association between lottery position and gamble choice.

4.4 | Descriptive Statistics at the Participant-Round Level

Table 5 presents summary statistics at the participant-round level. In each round, the size of the participant's harvest and the mean of the price offered by the uncertain-price buyer both vary randomly according to a roll of a 12-sided die. Section 3 gives more details. We code both of these experimental variables as dummy variables with four and three possibilities, respectively. Perfectly randomized experimental variables would exhibit sample probabilities of 0.25 for each possibility of the harvest and 0.33 for each possibility of the mean price of the uncertain-price buyer. Our sample slightly favors a harvest of 6 or 8 quintals and a mean price of the uncertain-price buyer of MXN 50/kg due to physical idiosyncrasies with the die.

4.5 | Outcomes of Interest

The outcome of interest is the share of the harvest that participants allocate to the certain-price buyer in each round of the experiment. We compute it as follows. Let i denote the participant, $g \in \{1, 2, 3\}$ denote the game, and $t \in \{1, 2, \ldots, 20\}$ denote the round. In each round, participants learn the harvest quantity, $q^g_{i,t} \in \{2, 4, 6, 8\}$, and the mean price of the uncertain-price buyer $p^{pg}_{i,t} \in \{45, 50, 55\}$. They choose how many quintals $z^g_{i,t} \in \{0, 1, 2, 3, 4, 5, 6, 7, 8\}$ to allocate to the certain-price buyer. We compute the share as $\delta^g_{i,t} = z^g_{i,t}/q^g_{i,t}$.

When we pool allocation decisions for all three games for the same participant, the notation above changes slightly. Here we denote the round as $t \in \{1, 2, \ldots, 60\}$ and drop the g superscript from the harvest quantity and the mean price of the uncertain-price buyer, so they are $q_{i,t}$ and $p^p_{i,t}$, respectively. The participant's choice is $z_{i,t}$. We compute the share as $d_{i,t} = z_{i,t}/q_{i,t}$. For round-level regressions, our outcome of interest is precisely the game-level allocation $\delta^g_{i,t}$ or the pooled allocation $d_{i,t}$. The pooling of the allocations does not change their cardinal values. It just maps them from $\delta^g_{i,t}$ space where $g \in \{1, 2, 3\}$ and $t \in \{1, 2, \ldots, 20\}$ to $d_{i,t}$ space where $t \in \{1, 2, \ldots, 60\}$. Table 5 gives descriptive statistics for this outcome.

For the participant level regressions, we aggregate the pooled participant-round allocation $d_{i,t}$ across rounds as follows. Because one quarter of the sample ($n = 58$) allocate their entire harvest to the certain-price buyer in every round, we separate the overall margin into the extensive and intensive margin so that we can analyze them separately. Table 1 gives descriptive statistics for these outcomes.

1. The **overall margin** is the average allocation for a participant over 60 rounds, or $d_i = \frac{1}{60}\sum_{t=1}^{60} d_{i,t}$.
2. The **extensive margin** is an indicator variable of whether a participant allocates his or her entire harvest to the certain-price buyer in all rounds, or $\bar{d}_i = I[d_i = 1]$.
3. The **intensive margin** is the average allocation of those participants who do not allocate their entire harvest to the certain-price buyer in all rounds.

Figure 12 presents a histogram of the overall margin broken down into participants who received the MXN 3000 additional income treatment and those who did not. The left shift in the allocation of the additional income group suggests that the treatment is associated with a decrease in the overall margin.

Figure 13 presents a histogram of the overall margin broken down by cooperative membership status. The right shift in the allocation of the non-members suggests that cooperative membership status is associated with a decrease in the incidence of side-selling.

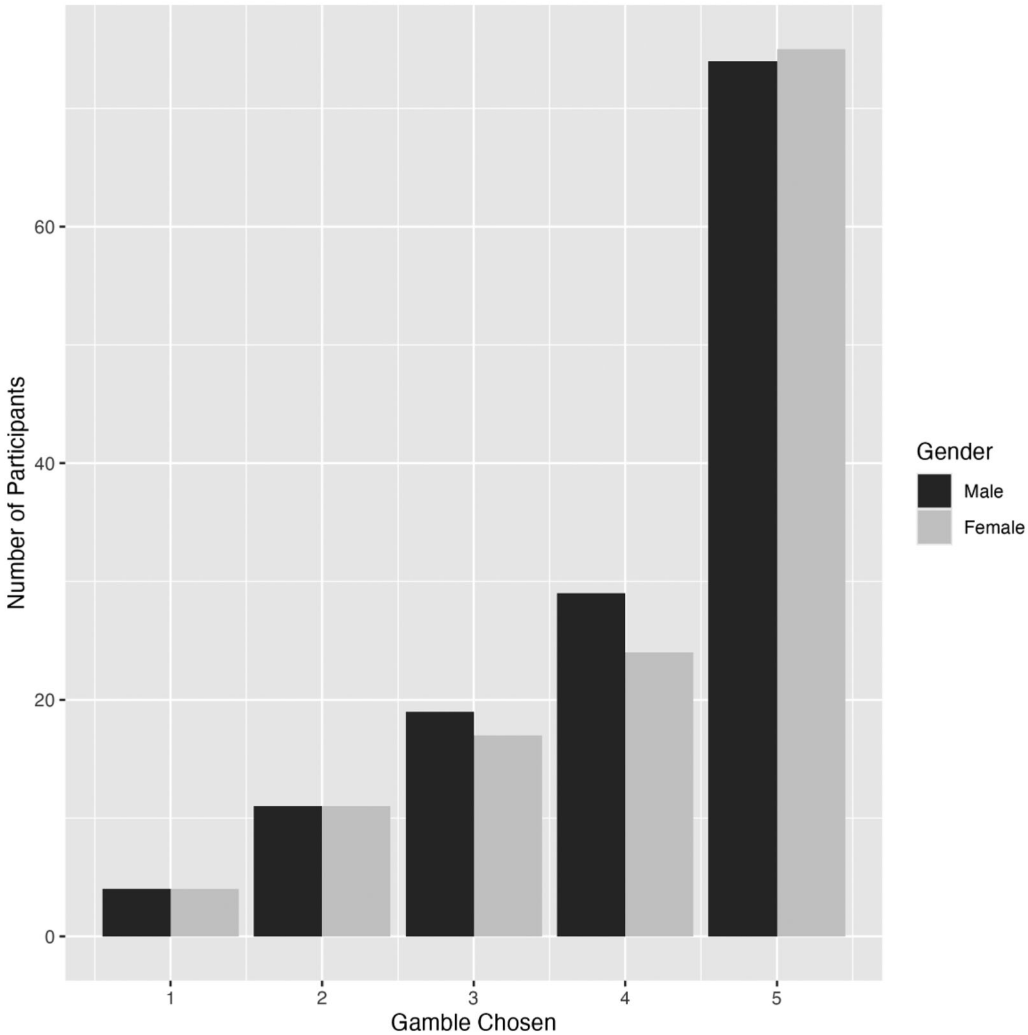

FIGURE 8 | Lottery gamble choices by gender. This figure displays a histogram of gamble choices from a no-loss lottery based on Eckel and Grossman (2008). Table 3 describes the choices. It is comparable to Figure 1 in that paper. Here we do not see differences between the gamble choices of men and women.

4.6 | Payoff Function

We put the payoff function of the experiment below. We suppress the subscript i for each participant and consider the arrangement of the data in which the three games are pooled together into 60 rounds per individual. Each round is denoted by t. In round t, the harvest quantity is denoted by q_t, the realized price of the uncertain-price buyer by p_t^p, and the fraction of the allocation to the certain-price buyer by δ_t. The payoff of the Eckel–Grossman lottery is denoted by L. The indicator variable extra$_i$ is 1 if the participant receives the additional income treatment and 0 otherwise.

$$\Pi = L + \sum_{t=1}^{60} (3000 \cdot \text{extra} + \delta_t \cdot q_t \cdot 50 + (1 - \delta_t) \cdot q_t p_t^p) \qquad (1)$$

5 | Empirical Framework

We now describe our empirical framework. First, we discuss our estimation strategy at the participant-game-round level, the participant-round level, and the participant level. In particular, we use moderation analysis at the participant level to estimate the effect of the additional income treatment moderated by risk aversion as measured by the Eckel–Grossman lottery and moderated by loyalty to the cooperative as measured by years of participation. Next, we discuss our identification strategy. Finally, we discuss subgroup analysis among cooperative members and non-members to test for heterogeneous treatment effects.

5.1 | Estimation Strategy

We estimate the effect of four sources of variation on the marketing decisions of participants: the presence of additional income, a change in the framing of the certain-price buyer, an increase or decrease in the harvest quantity, and an increase or decrease in the mean price offered by the uncertain-price buyer. Since these four sources of variation vary at three levels, our estimation strategy operates at three levels. First, we estimate the effect of the harvest quantity and the mean price offered by the uncertain-price buyer at the participant-game-round level. Next,

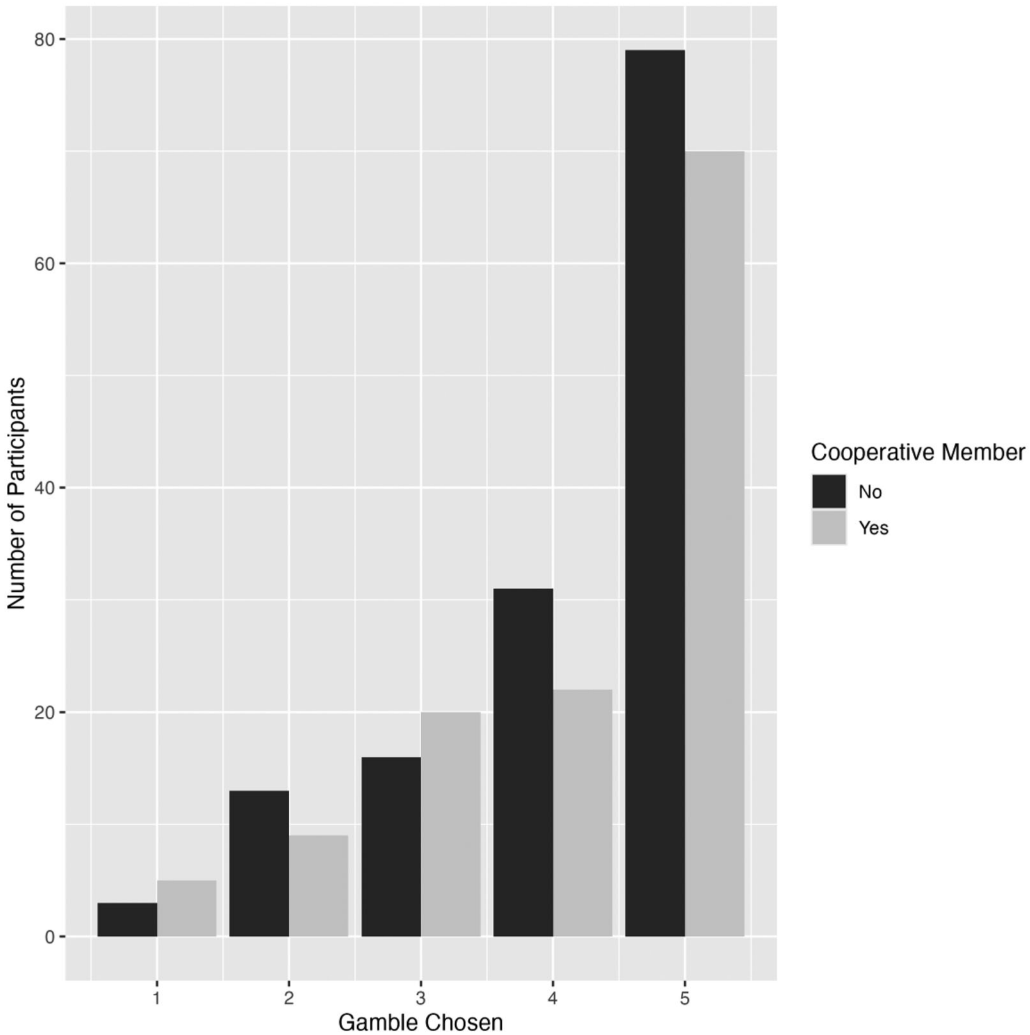

FIGURE 9 | Lottery gamble choices by cooperative membership status. This figure displays a histogram of gamble choices from a no-loss lottery based on Eckel and Grossman (2008). Table 3 describes the choices. It is broken down by cooperative membership status of the participants. Cooperative members are slightly more risk-averse than cooperative non-members.

we pool all three games and estimate the effect of harvest quantity, mean price offered by uncertain-price buyer, and game framing, this time at the participant-round level. Finally, we aggregate participants' allocations across all 60 rounds and estimate the effect of the additional income treatment at the participant level.

5.1.1 | Estimation at the Participant-Game-Round Level

Recall from Section 4.5 that we denote round-level outcomes in two ways to distinguish between the estimation in this section, which separates allocations by game, and the estimation in the next section, which pools allocations across all three games. Table 5 gives descriptive statistics for both outcomes of interest.

1. The expression $\delta_{i,t}^{g}$ denotes the share that participant i allocates to the certain-price buyer in round t of game g. Here $g \in \{1, 2, 3\}$ and $t \in \{1, 2, \ldots, 20\}$.
2. The expression $d_{i,t}$ denotes the share that participant i allocates to the certain-price buyer in round t. Here $t \in \{1, 2, \ldots, 60\}$.

We estimate the following equation for each game:

$$\delta_{i,t}^{g} = \alpha_i^{g} + \sum_{s\in\{45,55\}} \beta_s^{pg} I\left[p_{i,t}^{pg} = s\right] + \sum_{h\in\{2,6,8\}} \beta_h^{qg} I\left[q_{i,t}^{g} = h\right] + \lambda^{g} t + \varepsilon_{i,t}^{g} \quad (2)$$

To allow for non-linear effect of variation in the mean price offered by the uncertain-price buyer and the harvest quantity, we code both variables using dummy variables. First, we code the mean of the price offered by the uncertain-price buyer with the dummy variables $I[p_{i,t}^{pg} = s]$. The coefficients β_s^{pg} compare two alternative prices to a reference price of MXN 50/kg. In the first case, the mean price of MXN 45/kg is below the reference price, and in the second case the mean price of MXN 55/kg is above the reference price. Recall that the reference price is the same as the price that is always offered by the certain-price buyer.

Similarly, we code the participant's harvest quantity with the dummy variables $I[q_{i,t}^{g} = h]$. The coefficients β_h^{qg} compare three alternative harvests to a reference harvest of 4 quintals. Recall

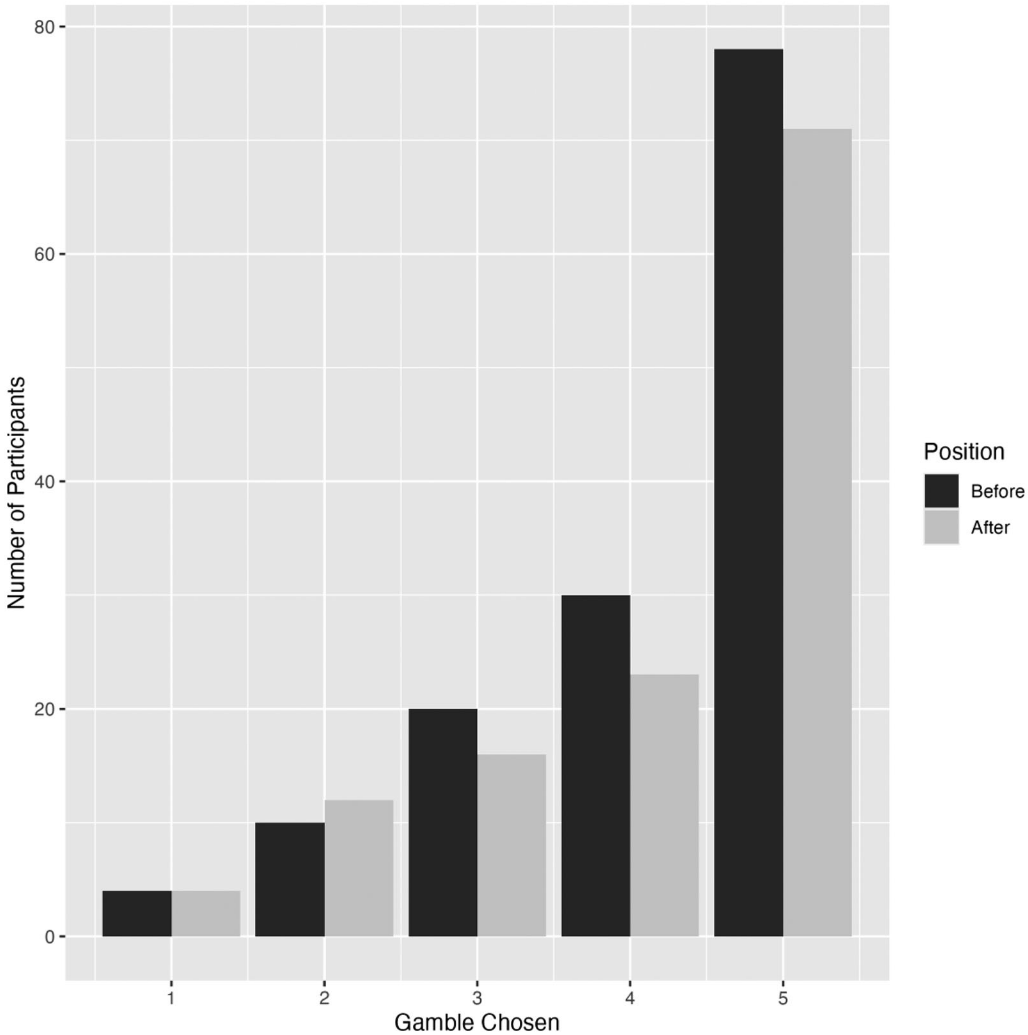

FIGURE 10 | Lottery gamble choices by position. This figure displays a histogram of gamble choices from a no-loss lottery based on Eckel and Grossman (2008). Table 3 describes the choices. It is broken down by whether participants completed the lottery before or after the game. It suggests that the distribution of responses is not associated with the lottery position.

that 1 quintal is 60 kg. In the first case, the harvest quantity is half the size of the reference harvest quantity (2 quintals), and in the second and third cases it is 50% larger (6 quintals) or double (8 quintals) the size of the reference harvest quantity. We use 4 quintals (240 kg) as a reference harvest quantity because this possibility is closest to the typical quantity of participants' harvests in real-life. The exit survey indicates that the mean coffee harvest quantity of the sample is 371 kg and the median coffee harvest quantity is 270 kg.

In both this participant-game-round estimating equation and in the participant-round estimating equation below, we include a linear time trend to control for the effect of later rounds. The effect could be positive (participant learning) or negative (participant fatigue or boredom). Here, this time trend is denoted by λ^g. As we discuss in Section 5.2 below, we include participant fixed effects α_i^g to control for unobserved participant heterogeneity that does not vary by round. Following Boyd and Bellemare (2022), we cluster standard errors at the participant level to allow for correlation among unobservables within rounds played by the same participant.

5.1.2 | Estimation at the Participant-Round Level

Next, we augment Equation (2) with additional dummy variables for Game 2 and Game 3 denoted by $I[g_{i,t} = c]$. The new equation appears as Equation (3) below. Recall that Game 2 and Game 3 vary the framing of the certain-price buyer. Section 3 gives more detail. The new coefficients c_g capture the effect of the variation in framing.

The remaining coefficients use Latin letters to refer to the same parameters denoted by Greek letters in Equation (2). The coefficients b_s^p capture variation in the mean price offered by the uncertain-price buyer, and the coefficients b_h^q capture variation in harvest quantity. As before, we include participant fixed effects a_i and a linear time trend l. We pool participant results across all three games and estimate this equation on the pooled sample.

$$d_{i,t} = a_i + \sum_{s\in\{45,55\}} b_s^p I\left[p_{i,t}^p = s\right] + \sum_{h\in\{2,6,8\}} b_h^q I\left[q_{i,t} = h\right] + \sum_{g\in\{2,3\}} c_g I\left[g_{i,t} = c\right] + lt + e_{i,t} \tag{3}$$

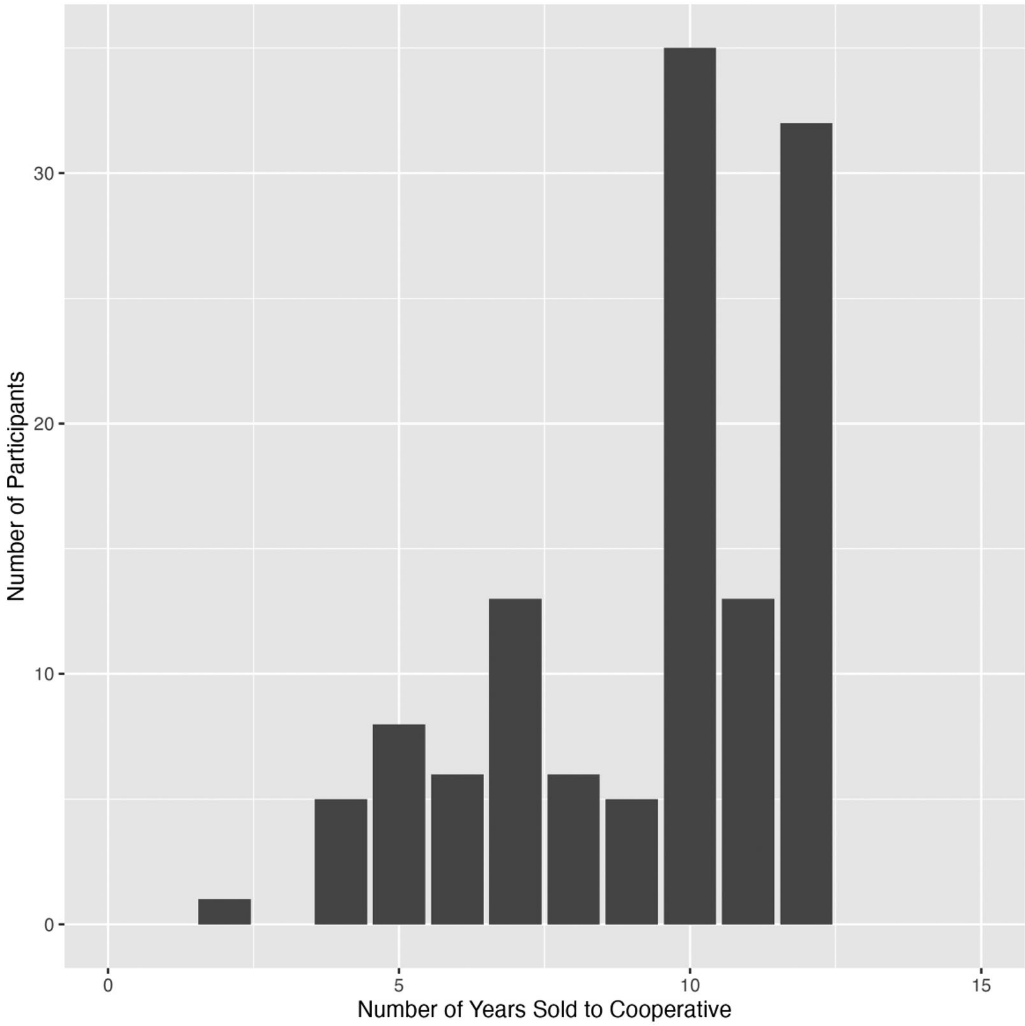

FIGURE 11 | Cooperative member loyalty. This figure displays a histogram of the number of years in 2013–2024 that participants who are cooperative members ($n = 124$) delivered coffee to the cooperative. It is based on administrative data from the Ts'umbal Xitalha' coffee cooperative.

5.1.3 | Estimation at the Participant Level

Finally, we consider the allocation decisions of participants in all three games. As Section 4.5 describes, we average participants' allocation to the certain-price buyer across all 60 rounds, which we denote by d_i below. Wollni and Fischer (2015) use a similar outcome of interest: the fraction of coffee harvest sold to one buyer. They note that this dependent variable is a fractional variable bounded between 0 and 1. For this reason, they use the quasi-likelihood estimator proposed by Papke and Wooldridge (1996).

We do not follow their approach. Instead, we estimate Equation (4) separately for the overall margin, the extensive margin, and the intensive margin. This method resembles the double-hurdle model used by Shumeta et al. (2018) with the added benefit that the point estimates are directly interpretable.

$$d_i = \theta_1 \text{extra}_i + \beta_1 X_i + \varepsilon_{1i} \tag{4}$$

The coefficient of interest is θ_1, the effect of the additional income on these three outcomes. In addition, as controls, we include the following covariates: age, gender, education level, CRRA calculated based on the Eckel–Grossman lottery, completion of the practice game, reported literacy, correct answer on the probability filter question, game order, and lottery position. Since the unit of analysis is the participant and the treatment is at the participant level, we do not cluster the standard errors. We simply compute heteroskedasticity-robust standard errors.

We use an augmented version of Equation (4) to examine the effect of the additional income treatment moderated by two characteristics of the participants. First, we estimate the effect of the treatment moderated by CRRA for the full sample as well as for subsamples of cooperative members and non-members. Second, we estimate the effect of the additional income treatment moderated by cooperative loyalty as measured by the number of years that the participant sold to the cooperative for a subsample of cooperative members. In both cases, the covariate Z_i denotes the moderator.

$$d_i = \theta_2 \text{extra}_i + \gamma Z_i + \tau \text{extra}_i Z_i + \beta_2 X_i + \varepsilon_{2i} \tag{5}$$

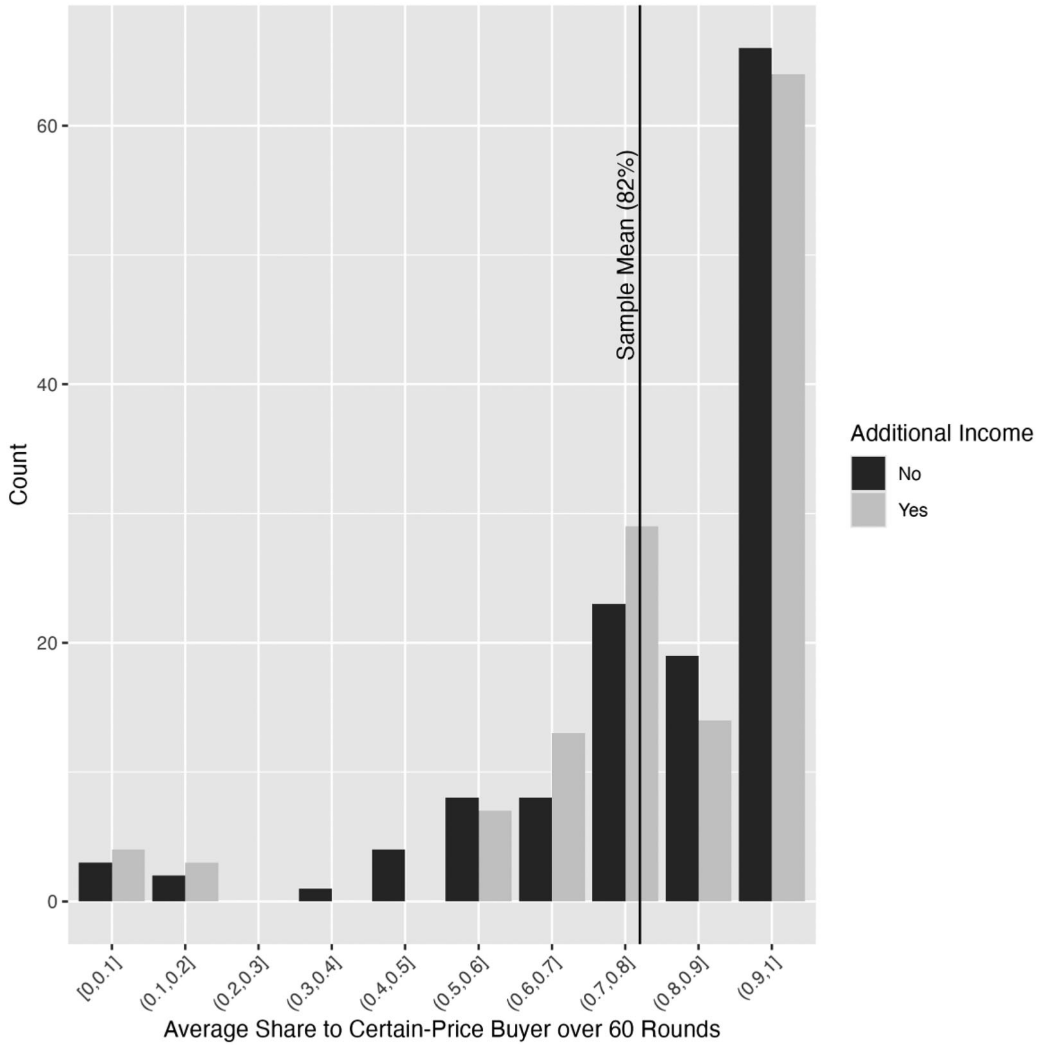

FIGURE 12 | Total margin by treatment status. This figure displays a histogram of the average share of harvest that participants allocate to the certain-price buyer over all 60 rounds of the experiment, broken down by treatment status. There are 268 total participants in the experiment. One hundred and thirty-four receive the treatment, which is MXN 3000 of additional income in every round.

Here, there are three coefficients of interest. First, the coefficient θ_2 captures the overall effect of the additional income treatment. Second, the coefficient γ captures the effect of the moderator. Third, the coefficient τ captures the additional treatment effect of a one-unit increase in CRRA or a further year of loyalty to the cooperative. Once again β_2 captures the effect of the vector of controls.

5.2 | Identification Strategy

First, we consider identification for the estimations at the participant-game-round level and the participant-round level. Within each game, at the round level, we randomize the harvest quantity and the mean of the price offered by the uncertain-price buyer, so the corresponding coefficients in Equations (2) and (3) are causally identified. Across the three games, the order is randomized and participants play all three games, so we argue that the additional coefficients for Game 2 and Game 3 in Equation (3) are also causally identified.

Two concerns remain for causal identification. First, we consider the potential correlation between the share allocated to the certain-price buyer in each round and unobservable characteristics at the participant level such as risk preference or skill at playing the game. We use participant fixed effects to control for these unobservable characteristics. Second, participants' allocation decisions in earlier rounds and later rounds might differ in unobservable ways, due to participant learning or fatigue. For this reason, all participants play 10 rounds of a practice game that are not counted, either in their overall score in the game or in our analysis. The practice game controls for participants who learn the game faster than others. Moreover, we include a linear-time trend to control for additional learning, boredom, or fatigue.[12]

Next, we consider identification for the estimation at the participant level in Equations (4) and (5). Here, the additional income treatment is randomized at the participant level, so the parameters θ_1 and θ_2 are causally identified. Moreover, CRRA and participant loyalty are considered exogenously fixed prior to the experiment, so we argue that the parameters γ for the direct

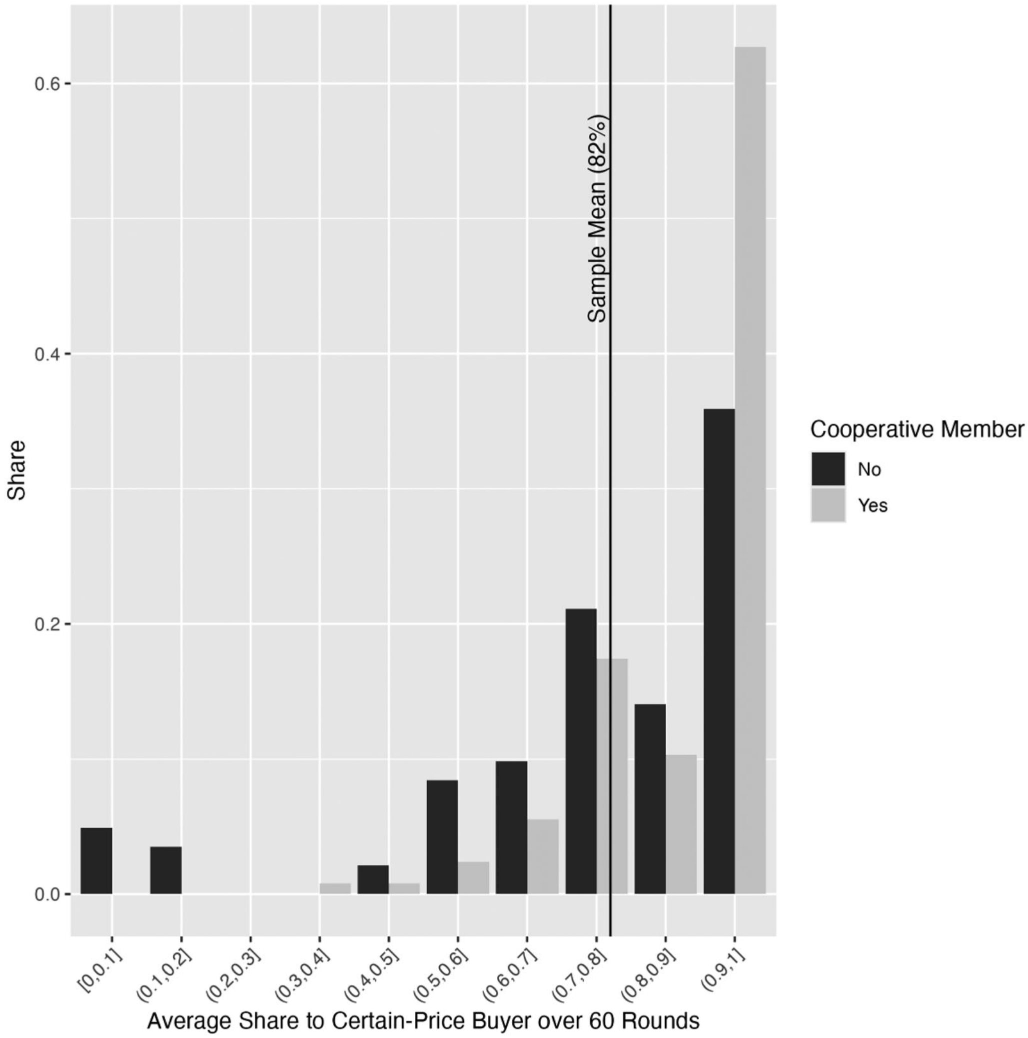

FIGURE 13 | Total margin by cooperative membership status. This figure displays a histogram of average share allocated to certain-price buyer over all 60 rounds by participants, broken down by cooperative membership status.

effect and τ for the interaction effect of these moderators are also causally identified.

5.3 | Subgroup Analysis

We would like to estimate the effect of the four factors above separately for cooperative members and non-members to uncover potentially heterogeneous treatment effects. Recall that 126 of our 268 participants are cooperative members. Cooperative membership is a time-invariant participant characteristic, so we cannot include a membership dummy in Equations (2) or (3) because it would be absorbed in the participant fixed effects. Moreover, it is a choice variable based on observed and unobserved characteristics, so we cannot add it to the vector of controls X in 4.

For this reason, we use subgroup analysis. We estimate Equations (3) and (4) separately for cooperative members and non-members to allow for a comparison of the estimated parameters. We argue that the parameters in these estimated results are causally identified for the reasons we discuss in the previous section. One drawback to this approach is the reduced sample size in the subsamples of 126 members and 142 non-members compared to the full sample of 268 members. This reduced sample size limits the statistical power of the associated hypothesis tests.

6 | Results and Discussion

In this section, we first present estimation results at the participant-game-round level (Equation 2) and the participant-round level (Equation 3). Next, we present estimation results at the participant level on the full sample (Equations 4 and 5). Finally, we present estimation results at the participant level on the subsamples of cooperative members and non-members.

6.1 | Participant-Game-Round Level Results

Table 6 presents the results of the estimation of Equation (2) at the participant-game-round level. Recall from Table 5 that the baseline allocations to the certain-price buyer for Game 1, Game

TABLE 5 | Descriptive statistics at the participant-round level.

	Game 1		Game 2		Game 3		Pooled	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Experimental Variables								
Harvest 2 quintals (1 = Yes)	0.156	(0.363)	0.154	(0.361)	0.152	(0.359)	0.154	(0.361)
Harvest 4 quintals (1 = Yes)	0.198	(0.398)	0.208	(0.406)	0.193	(0.394)	0.199	(0.399)
Harvest 6 quintals (1 = Yes)	0.305	(0.460)	0.319	(0.466)	0.327	(0.469)	0.317	(0.465)
Harvest 8 quintals (1 = Yes)	0.341	(0.474)	0.320	(0.466)	0.329	(0.470)	0.330	(0.470)
Mean of uncertain-price buyer MXN 45/kg (1 = Yes)	0.204	(0.403)	0.211	(0.408)	0.203	(0.402)	0.206	(0.405)
Mean of uncertain-price buyer MXN 50/kg (1 = Yes)	0.431	(0.495)	0.431	(0.495)	0.418	(0.493)	0.426	(0.495)
Mean of uncertain-price buyer MXN 55/kg (1 = Yes)	0.365	(0.481)	0.358	(0.480)	0.379	(0.485)	0.368	(0.482)
Outcome of interest								
Allocation to certain-price buyer	0.820	(0.275)	0.826	(0.268)	0.818	(0.277)	0.821	(0.273)
Observations								
Participants	268	—	268	—	268	—	268	—
Rounds	5360	—	5360	—	5360	—	16080	—

TABLE 6 | Impact on share to certain-price buyer by game.

	***Dependent variable*:**		
	Share sold to certain-price buyer		
	Game 1	**Game 2**	**Game 3**
	(1)	**(2)**	**(3)**
Harvest 2 quintals (1 = Yes)	−0.035** (0.009)	−0.036** (0.009)	−0.015 (0.010)
Harvest 6 quintals (1 = Yes)	0.003 (0.006)	0.001 (0.006)	0.018** (0.006)
Harvest 8 quintals (1 = Yes)	−0.021* (0.008)	−0.021** (0.006)	−0.014* (0.007)
Mean of uncertain-price buyer MXN 45/kg (1 = Yes)	−0.025** (0.007)	−0.024** (0.007)	−0.022** (0.007)
Mean of uncertain-price buyer MXN 55/kg (1 = Yes)	−0.005 (0.006)	0.002 (0.005)	−0.003 (0.006)
Linear time trend	0.0001 (0.001)	−0.00001 (0.0004)	0.001 (0.0004)
Participant fixed effects	Y	Y	Y
Participants	268	268	268
Rounds	60	60	60
Baseline allocation	0.820	0.826	0.818
Observations	5360	5360	5360

Notes: Standard errors are clustered at the participant level. Reference harvest is 4 quintals. Reference mean of price offered by uncertain-price buyer is MXN 50. In columns (1), (2), and (3), certain-price buyer offers MXN 50. In column (2), certain-price buyer also offered microcredit to participant last year. In column (3), certain-price buyer is a cooperative that offered microcredit and technical assistance last year.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

2, and Game 3 are 82%, 83%, and 82%, respectively. The strong preference of the participants for price certainty stands out as the most important result at the participant-game-round level and the participant-round level. These allocations reveal an 18% incidence of side-selling. This estimate is higher than the 12% incidence of side-selling reported by Keenan et al. (2024), Woldie (2010), and Wollni and Fischer (2015) and close to the 20% incidence of side-selling reported by Ewusi Koomson et al. (2022). It is lower than the estimates of the other studies we cite in the Introduction, which range from 30% to 55%.

Moreover, this high baseline provides context to the point estimates below. Our point estimates of the effect of varying the harvest quantity, varying the mean of the price offered by the uncertain-price buyer, and varying the framing of the certain-price buyer range between 1% and 4%. These effect sizes may seem small, but we argue that they are still important relative to the overall incidence of 18% of side-selling.

We first examine this effect of varying the harvest quantity. Reducing the harvest quantity by half from the reference of 4 quintals to 2 quintals increases the incidence of side-selling by 3%. Increasing it by 50% from the reference of 4 to 6 quintals does not affect side-selling. Doubling it from 4 to 8 quintals, however, increases the incidence of side-selling, this time by 2%. These point estimates of the effect of varying harvest quantity on the incidence of side-selling are comparable in magnitude to the effect sizes of Keenan et al. (2024), which range from 1% to 7%. Interestingly, their effect sizes are negative, while ours are positive. On the other hand, our effect sizes are the same sign and approximately the same magnitude that Wollni and Fischer (2015) find, although their use of nonlinear econometric methods makes a direct comparison of point estimates difficult.

To shed light on this puzzle, we use the general framework of Fafchamps and Hill (2005), who examine the distinction between selling at the farmgate and going to the market. These authors suggest that producers only travel to market when they have a sufficient quantity to justify the fixed cost of the trip. In other words, producers with a medium harvest tend to travel more to the market than producers with a small harvest. However, producers with large harvest do not travel to the market as frequently because the opportunity cost of time for them is too high. In our study context, local traders come to the farmgate while the cooperative recollection points are at a distance. Thus, in our study, participants will only deliver their harvest to the cooperative if they have enough to justify the trip, but not so much that the opportunity cost of time is too high. The context of Wollni and Fischer (2015) is the same and, for this reason, the sign of their results matches that of ours. In contrast, in the context of Keenan et al. (2024), the cooperative is near and the local traders are far away, so their results have the opposite sign. Producers with a small harvest do not side-sell as much because they cannot justify the fixed cost of the trip to the local traders. Producers with a large harvest have better things to do with their time.

Next, we examine the effect of varying the mean of the price offered by the uncertain-price buyer, which is a proxy for a change in market conditions or a change in transaction costs. We see that an MXN 5/kg reduction is associated with a 2% increase in side-selling. This result does not match profit-maximizing behavior, and we cannot find an easy explanation for it. Our hypothesis is that this result reflects a characteristic of the local context. Perhaps hearing about a reduction in the price of the local trader causes producers to think that the price will rise in the future. A MXN 5/kg increase in the mean of the price offered by the uncertain-price buyer does not affect the allocation decision.

When we compare the estimation results across the three games (columns 1, 2, and 3), we do not find much difference. The baseline allocations for all three games are very close. Moreover, so are the coefficients for the variation in harvest size and mean of the price offered by the uncertain-price buyer. These similarities suggest that varying the framing of the certain-price buyer does not make a difference in the allocation decision. These results contrast with those of Mujawamariya et al. (2013), which studies side-selling in a context where some local traders offer credit and others do not, so the provision of credit by some traders induces producers to market their production through these traders. Similarly, Ewusi Koomson et al. (2022) find that access to extension services provided by the cooperative (credit and technical assistance) reduces the incidence of side-selling.

6.2 | Participant-Round Level Results

Table 7 presents results from estimating Equation (3), a specification that augments Equation (2) with dummies for Game 2 and Game 3, on a pooled sample that combines participant allocation decisions across all three games. The point estimates here do not differ meaningfully from those in the previous specification. The framing of the certain-price buyer in Game 2 (microcredit) appears not to affect the allocation decision. The framing of the certain-price buyer in Game 3 (cooperative with microcredit and technical assistance) causes participants to allocate 1% less coffee to the certain-price buyer, but the point estimate lacks statistical significance. As we mentioned above, these results differ from those of Ewusi Koomson et al. (2022) and Mujawamariya et al. (2013).

6.3 | Participant-Level Results

In this section, we first examine the baseline direct effect of the additional income treatment on the average allocation of participants in all rounds of the game. Then we examine the indirect effect of risk aversion on this average allocation.

Table 8 presents the results of the estimation of Equation (4) at the participant level. Recall from Table 1 that 58 of 268 participants allocate the entire harvest to the certain-price buyer in every round. Thus, we separate the overall margin into the extensive and intensive margin.

At the extensive margin, the presence of additional income increases the likelihood by 10.0% that a participant will not side-sell to the cooperative at all. This result differs from that of Keenan et al. (2024), who find that non-farm income only reduces side-selling within the same producer (variation in non-farm income over the 3-year panel), but not between producers. Moreover, our treatment effect of 10.0% is much higher than theirs of 1.5%. In contrast, it matches that of Shumeta et al. (2018), who find a larger effect of off-farm income at the extensive margin than at the intensive margin. In their sample, 49 of 190 Ethiopian coffee farmers are completely loyal to the cooperative. 67% of the loyal farmers have off-farm income, while only 23% of the side-selling farmers do. We improve on their results by randomizing the presence of off-farm income. Our result also matches that of Geng et al. (2023), who find that an unexpected health shock (which they use as a proxy for an income shock) in a given week decreases the share of milk delivered to a dairy cooperative in the same or subsequent week by 2.5%.

The presence of additional income does not affect side-selling behavior at the overall margin. The effect at the intensive margin is also small (−1.9%) and not statistically significant.

Three covariates are associated with allocation decisions at the participant level: completed only middle school, understanding probability, and completing the practice game. All increase side-selling behavior. We present these as associations that warrant further study. Wollni and Fischer (2015) and Keenan et al. (2024) also find an association between an increase in the education level of producers and side-selling behavior.

TABLE 7 | Impact on share to certain-price buyer.

	***Dependent variable*:** **Share sold to certain-price buyer**
Harvest 2 quintals (1 = Yes)	−0.030** (0.007)
Harvest 6 quintals (1 = Yes)	0.007* (0.004)
Harvest 8 quintals (1 = Yes)	−0.017** (0.006)
Mean of uncertain-price buyer MXN 45/kg (1 = Yes)	−0.024** (0.005)
Mean of uncertain-price buyer MXN 55/kg (1 = Yes)	−0.003 (0.004)
Game 2 (Microcredit)	0.001 (0.007)
Game 3 (Cooperative with microcredit and technical assistance)	−0.011 (0.011)
Linear time trend	0.0002 (0.0003)
Participant fixed effects	Y
Participants	268
Rounds	60
Baseline allocation	0.821
Observations	16,080

Notes: Standard errors are clustered at the participant level. Reference harvest is 4 quintals. Reference mean of price offered by uncertain-price buyer is MXN 50.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

TABLE 8 | Participant level outcomes.

	Average allocation to certain-price buyer over 60 rounds		
	Overall margin (1)	**Extensive margin (2)**	**Intensive margin (3)**
MXN 3000 additional income	0.001 (0.025)	0.100* (0.051)	−0.019 (0.030)
Female (1 = Yes)	0.007 (0.027)	0.029 (0.056)	−0.007 (0.033)
Age	−0.0003 (0.001)	−0.0005 (0.002)	−0.0004 (0.001)
Completed only middle school (1 = Yes)	−0.099* (0.052)	−0.159* (0.068)	−0.080 (0.057)
Completed high school (1 = Yes)	−0.044 (0.054)	0.020 (0.093)	−0.053 (0.071)
Played practice game (1 = Yes)	−0.137** (0.035)	−0.275** (0.088)	−0.116* (0.050)
Understands probability (1 = Yes)	−0.091** (0.031)	−0.161* (0.066)	−0.052 (0.037)
Can read/write (1 = Yes)	0.020 (0.037)	0.036 (0.063)	0.013 (0.044)
Constant	0.971** (0.099)	0.485** (0.170)	0.913** (0.115)
Game order, lottery position, lottery outcome controls	Y	Y	Y
Observations	268	268	210
*R*2	0.134	0.110	0.123

Notes: In column (2), the dependent variable is a dummy which equals 1 if the participant allocates the entire harvest to the certain-price buyer in all rounds; 0 otherwise. Column (3) presents the same regression as column (1) on the subset of participants for whom the dummy variable is 0. All three columns present heteroskedasticity-robust standard errors.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Next, we turn to the moderating effect of risk aversion on side-selling. Table 9 presents the results of the estimation of Equation (5) at the participant level. Recall that Equation (5) augments Equation (4) with an interaction term of the participants' CRRA as measured by the Eckel–Grossman lottery. Half of participants completed the lottery before the experiment and half after the experiment. As Figure 10 shows, we find the same distribution of lottery choice for both groups, so we argue that lottery placement does not affect lottery choice.

In general, we find that increased risk aversion decreases side-selling, consistent with Woldie (2010). Interpreting the results, we find a baseline effect of the additional income of 6.7% at the extensive margin that increases by 7.5% with each one-

TABLE 9 | Participant level outcomes moderated by CRRA.

	Average allocation to certain-price buyer over 60 rounds		
	Overall margin	**Extensive margin**	**Intensive margin**
	(1)	**(2)**	**(3)**
MXN 3000 additional income	0.006 (0.033)	0.067 (0.066)	−0.009 (0.038)
CRRA	0.016 (0.020)	−0.041 (0.044)	0.030 (0.023)
Additional income * CRRA	−0.001 (0.028)	0.075 (0.085)	−0.013 (0.031)
Female (1 = Yes)	0.003 (0.028)	0.038 (0.055)	−0.014 (0.034)
Age	−0.0003 (0.001)	−0.0001 (0.002)	−0.0004 (0.001)
Completed only middle school (1 = Yes)	−0.099* (0.052)	−0.148* (0.069)	−0.080 (0.058)
Completed high school (1 = Yes)	−0.050 (0.053)	0.035 (0.093)	−0.059 (0.070)
Played practice game (1 = Yes)	−0.145** (0.034)	−0.296** (0.087)	−0.124* (0.049)
Understands probability (1 = Yes)	−0.089** (0.031)	−0.155* (0.065)	−0.052 (0.037)
Can read/write (1 = Yes)	0.019 (0.037)	0.041 (0.062)	0.006 (0.045)
Constant	1.010** (0.092)	0.551** (0.168)	0.943** (0.110)
Game order, lottery position, lottery outcome controls	Y	Y	Y
Observations	268	268	210
R2	0.132	0.129	0.119

Notes: In column (2), the dependent variable is a dummy which equals 1 if the participant allocates the entire harvest to the certain-price buyer in all rounds; 0 otherwise. Column (3) presents the same regression as column (1) on the subset of participants for whom the dummy variable is 0. All three columns present heteroskedasticity-robust standard errors.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

unit increase in the CRRA. Table 3 shows the estimated CRRA range given by each lottery choice. The treatment effect for lottery choice 1 (CRRA = 2) is 13.5%. The treatment effect for lottery choice 5 (CRRA = 0.2) is 7.4%. These results imply that additional income reduces side-selling more for more risk-averse participants. They match those of Boyd and Bellemare (2022) and Bellemare et al. (2020), who both used estimated participant risk preferences from risk-elicitation lotteries and found differential effects of the provision of crop insurance. However, as in these two prior studies, our results here also lack statistical significance.

6.4 | Subgroup Analysis by Cooperative Membership

Finally, we estimate the round-level outcomes and the participant-level outcomes separately for cooperative members and non-members. Recall that Figure 13 shows a histogram of the participant level outcomes broken down by cooperative membership status. Throughout this section, the smaller sample size (126 members and 142 non-members) of the two subgroups limits the statistical power of the hypothesis tests. However, we argue that the differences in the point estimates warrant the analysis.

6.4.1 | Participant-Round Level Results

Table 10 presents estimation results at the participant-round level separately for cooperative members and non-members. We see differential effects for changes in harvest quantity and uncertain-price buyer between members and non-members. We consider first the case of an 8 quintal harvest relative to the reference harvest of 4 quintals. For non-members, the point estimates that we saw in the overall sample double (3.2% vs. 1.7%). For members, doubling the harvest size does not affect the allocation decision. This difference indicates that non-members value profit maximization more than price certainty.

Next, we consider the case of a 2 quintal harvest relative to the reference harvest of 4 quintals. Recall the overall effect of 3.0% from Table 7. In the subgroup analysis, members side-sell 2.5% more of their harvest and non-members side-sell 3.6%, respectively. In contrast to the situation above, here both groups choose profit maximization over loyalty to the cooperative. In interpreting these coefficients, we note that participants in the experiment only have three choices to allocate their harvest: 2 quintals, 1 quintal, or 0 quintal to the certain-price buyer. Thus, instead of an average increase in side-selling of 2.5%, a better interpretation could be that 1 in 50 participants changed their allocation decision.[13]

Unlike in the pooled results, we find an effect of the experiment framing here. Access to microcredit decreases side-selling by 1.3%, indicating that cooperative members value this service. In the same vein as above, a better interpretation might be that approximately 1 in 100 cooperative member participants change their behavior when reminded of access to microcredit. In contrast, when the certain-price buyer is described to non-members as a cooperative, the framing reduces their allocation to the certain-price buyer by 3.2% (or 1 in 33). This result possibly indicates a dislike for cooperatives.

TABLE 10 | Impact on share to certain-price buyer by cooperative membership status.

	Dependent variable:	
	Share sold to certain-price buyer	
	Members	**Non-members**
	(1)	(2)
Harvest 2 quintals (1 = Yes)	−0.025** (0.009)	−0.036** (0.010)
Harvest 6 quintals (1 = Yes)	0.008* (0.003)	0.005 (0.006)
Harvest 8 quintals (1 = Yes)	−0.001 (0.006)	−0.032** (0.009)
Mean of uncertain-price buyer MXN 45/kg (1 = Yes)	−0.007* (0.004)	−0.041** (0.009)
Mean of uncertain-price buyer MXN 55/kg (1 = Yes)	−0.0003 (0.004)	−0.005 (0.006)
Game 2 (Microcredit)	0.013* (0.008)	−0.009 (0.011)
Game 3 (Cooperative with microcredit and technical assistance)	0.011 (0.011)	−0.032* (0.019)
Linear time trend	0.00002 (0.0002)	0.0004 (0.0004)
Participant fixed effects	Y	Y
Participants	126	142
Rounds	60	60
Observations	7560	8520

Notes: Standard errors are clustered at the participant level. Reference harvest is 4 quintals. Reference mean of price offered by uncertain-price buyer is MXN 50/kg.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

TABLE 11 | Participant level outcomes (cooperative members).

	Average allocation to certain-price buyer over 60 rounds		
	Overall margin	**Extensive margin**	**Intensive margin**
	(1)	**(2)**	**(3)**
MXN 3000 additional income	0.014 (0.024)	0.166* (0.083)	−0.012 (0.032)
Female (1 = Yes)	0.023 (0.032)	0.0005 (0.116)	0.014 (0.045)
Age	−0.0005 (0.001)	−0.002 (0.004)	−0.0004 (0.002)
Completed only middle school (1 = Yes)	−0.040 (0.052)	−0.213* (0.120)	−0.011 (0.064)
Completed high school (1 = Yes)	0.070 (0.051)	0.172 (0.186)	0.085 (0.086)
Played practice game (1 = Yes)	−0.080* (0.041)	−0.305* (0.128)	−0.051 (0.067)
Understands probability (1 = Yes)	−0.085** (0.027)	−0.214* (0.102)	−0.058 (0.042)
Can read/write (1 = Yes)	−0.052 (0.032)	−0.070 (0.105)	−0.054 (0.041)
Constant	1.091** (0.109)	0.880* (0.388)	0.979** (0.144)
Game order, lottery position, lottery outcome controls	Y	Y	Y
Observations	126	126	89
*R*2	0.204	0.210	0.161

Notes: In column (2), the dependent variable is a dummy which equals 1 if the participant allocates the entire harvest to the certain-price buyer in all rounds; 0 otherwise. Column (3) presents the same regression as column (1) on the subset of participants for whom the dummy variable is 0. All three columns present heteroskedasticity-robust standard errors.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

6.4.2 | Participant Level Results

Tables 11 and 12 present results for participant-level outcomes on subgroups of cooperative members and non-members, respectively. The smaller sample size (126 members and 142 non-members) limits the statistical power of the hypothesis tests. Nevertheless, we see a sharp contract in the point estimate of the additional income treatment at the extensive margin. For cooperative members, it is 16.3%, while for non-members it is 2.5%. This difference suggests that the additional income may relieve a budget constraint that allows cooperative members who already prefer price certainty to pursue it even more.

TABLE 12 | Participant level outcomes (cooperative non-members).

	Average allocation to certain-price buyer over 60 rounds		
	Overall margin	Extensive margin	Intensive margin
	(1)	(2)	(3)
MXN 3000 Additional Income	−0.035 (0.043)	0.023 (0.059)	−0.036 (0.045)
Female (1 = Yes)	0.070 (0.048)	0.115* (0.062)	0.047 (0.053)
Age	−0.001 (0.002)	−0.001 (0.002)	−0.0002 (0.002)
Completed only middle school (1 = Yes)	−0.097 (0.069)	−0.088 (0.090)	−0.101 (0.076)
Completed high school (1 = Yes)	−0.049 (0.071)	0.005 (0.109)	−0.051 (0.088)
Played practice game (1 = Yes)	−0.208** (0.061)	−0.161 (0.131)	−0.246** (0.077)
Understands probability (1 = Yes)	−0.106* (0.052)	−0.145* (0.082)	−0.047 (0.056)
Can read/write (1 = Yes)	0.117* (0.062)	0.177** (0.063)	0.088 (0.067)
Constant	0.923** (0.152)	0.143 (0.197)	0.932** (0.167)
Game order, lottery position, lottery outcome controls	Y	Y	Y
Observations	142	142	121
R2	0.206	0.155	0.202

Notes: In column (2), the dependent variable is a dummy which equals 1 if the participant allocates the entire harvest to the certain-price buyer in all rounds; 0 otherwise. Column (3) presents the same regression as column (1) on the subset of participants for whom the dummy variable is 0. All three columns present heteroskedasticity-robust standard errors.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Tables 13 and 14 present the results for the moderating effect of risk-aversion on the treatment effect of the additional income for cooperative members and non-members, respectively. Recall that Figure 9 shows a breakdown of lottery choice by members and non-members. Members are slightly more risk-averse than non-members.

In these estimation results, the baseline treatment effect of additional income at the extensive margin for cooperative members is comparable to the baseline treatment effect in Table 9 (4% vs. 6% reduction in likelihood of side-selling). However, we find that the differential effect by unit of CRRA is double for members compared to the overall sample (18.2% vs. 9.2% reduction in likelihood of side-selling). Moreover, when we examine non-members, we find a treatment effect in the opposite direction. A one unit increase in the CRRA increases the likelihood of side-selling by 11%. The opposite signs of these treatment effects in the two subgroups may indicate different underlying preferences at work. Cooperative members would like to remain loyal to the cooperative except when they are liquidity constrained and sell to the local trader by necessity. Non-members would like to maximize their profit and sell to the local trader except when they are liquidity constrained and sell to the certain-price buyer out of necessity.

Finally, we use administrative data from the cooperative to examine the moderating effect of member loyalty on the treatment effects of additional income. We measure member loyalty as the number of years in 2013–2024 that a participant who is a member has sold anything to the cooperative. Figure 11 shows the distribution of member loyalty. We estimate this effect using Equation (5), which incorporates loyalty as a moderator. Table 15 shows these results. At the baseline, we find that additional income is associated with a 49% decrease in side-selling by a hypothetical new member (loyalty of 0) This association decreases by 4% per year. At the mean value of loyalty (9.3 years), it is 12%. These results suggest that the larger number of marketing years a member sells to the cooperative, the less a liquidity constraint affects the decision to side-sell.

6.5 | Limitations

This experiment is the first that we know of that examines the determinants of side-selling. It suffers from at three limitations. First, we designed the state space of the experiment to correspond to the number of rounds (60), so that all participants would face all possible scenarios over the course of the three games. New technology in adaptive experiments would allow us to expand the state space.[14] For example, we could test more than three possibilities for the mean price of the uncertain-price buyer, more than four possibilities for harvest quantity, or more than one amount of additional income. With a larger state space, we could adapt the possibilities that participants are presented with in subsequent rounds based on participant performance in the initial rounds.

Second, the framing of the certain-price buyer was done verbally, while the other randomization was performed physically: small coffee bags for the coffee harvest, a die for the price of the uncertain-price buyer, and play money for the additional income.[15] This indigenous population may understand tactile variation better than verbal variation. In addition, the services offered by the framed buyers (microcredit and technical assistance) did not affect the results in the game. In real-life, microcredit would smooth consumption and technical assistance would affect harvest quantity. Subsequent experiments could add

TABLE 13 | Participant level outcomes moderated by CRRA (cooperative members).

	Average allocation to certain-price buyer over 60 rounds		
	Overall margin	**Extensive margin**	**Intensive margin**
	(1)	**(2)**	**(3)**
MXN 3000 additional income	0.007 (0.031)	0.066 (0.112)	−0.003 (0.042)
CRRA	−0.021 (0.018)	−0.061 (0.080)	−0.022 (0.020)
Additional income * CRRA	0.018 (0.031)	0.182 (0.133)	−0.017 (0.036)
Female (1 = Yes)	0.018 (0.034)	0.016 (0.112)	0.007 (0.046)
Age	−0.0004 (0.001)	−0.0004 (0.003)	−0.0004 (0.002)
Completed only middle school (1 = Yes)	−0.037 (0.053)	−0.233* (0.127)	−0.001 (0.066)
Completed high school (1 = Yes)	0.060 (0.052)	0.196 (0.204)	0.044 (0.093)
Played practice game (1 = Yes)	−0.093* (0.039)	−0.299* (0.119)	−0.070 (0.066)
Understands probability (1 = Yes)	−0.082** (0.027)	−0.216* (0.097)	−0.054 (0.042)
Can read/write (1 = Yes)	−0.043 (0.033)	−0.039 (0.101)	−0.052 (0.042)
Constant	1.160** (0.084)	0.831* (0.330)	1.101** (0.122)
Game order, lottery position, lottery outcome controls	Y	Y	Y
Observations	126	126	89
*R*2	0.221	0.246	0.169

Notes: In column (2), the dependent variable is a dummy which equals 1 if the participant allocates the entire harvest to the certain-price buyer in all rounds; 0 otherwise. Column (3) presents the same regression as column (1) on the subset of participants for whom the dummy variable is 0. All three columns present heteroskedasticity-robust standard errors.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

TABLE 14 | Participant level outcomes moderated by CRRA (cooperative non-members).

	Average allocation to certain-price buyer over 60 rounds		
	Overall margin	**Extensive margin**	**Intensive margin**
	(1)	**(2)**	**(3)**
MXN 3000 additional income	−0.008 (0.057)	0.058 (0.074)	−0.013 (0.059)
CRRA	0.045 (0.037)	−0.064 (0.057)	0.062 (0.039)
Additional income * CRRA	−0.043 (0.048)	−0.112 (0.075)	−0.029 (0.054)
Female (1 = Yes)	0.060 (0.050)	0.130* (0.064)	0.033 (0.056)
Age	−0.001 (0.002)	−0.0003 (0.002)	−0.0003 (0.002)
Completed only middle school (1 = Yes)	−0.100 (0.070)	−0.121 (0.088)	−0.093 (0.077)
Completed high school (1 = Yes)	−0.064 (0.072)	0.028 (0.107)	−0.071 (0.086)
Played practice game (1 = Yes)	−0.210** (0.062)	−0.183 (0.126)	−0.241** (0.079)
Understands probability (1 = Yes)	−0.105* (0.052)	−0.143* (0.083)	−0.047 (0.055)
Can read/write (1 = Yes)	0.116* (0.064)	0.203** (0.070)	0.074 (0.070)
Constant	0.913** (0.154)	0.228 (0.189)	0.903** (0.172)
Game order, lottery position, lottery outcome controls	Y	Y	Y
Observations	142	142	121
*R*2	0.211	0.182	0.216

Notes: In column (2), the dependent variable is a dummy which equals 1 if the participant allocates the entire harvest to the certain-price buyer in all rounds; 0 otherwise. Column (3) presents the same regression as column (1) on the subset of participants for whom the dummy variable is 0. All three columns present heteroskedasticity-robust standard errors.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

TABLE 15 | Participant level outcomes moderated by loyalty (cooperative members).

	Average allocation to certain-price buyer over 60 rounds		
	Overall margin	**Extensive margin**	**Intensive margin**
	(1)	**(2)**	**(3)**
MXN 3000 additional income	−0.0005 (0.111)	0.416 (0.347)	−0.043 (0.154)
Female (1 = Yes)	0.019 (0.035)	−0.004 (0.108)	0.012 (0.049)
Age	−0.001 (0.001)	−0.001 (0.003)	−0.001 (0.002)
Completed only middle school (1 = Yes)	−0.046 (0.049)	−0.235 (0.153)	−0.012 (0.061)
Completed high school (1 = Yes)	0.049 (0.062)	0.164 (0.194)	0.045 (0.105)
Played practice game (1 = Yes)	−0.094* (0.038)	−0.325** (0.119)	−0.073 (0.059)
Understands probability (1 = Yes)	−0.087** (0.031)	−0.239* (0.097)	−0.056 (0.047)
Can read/write (1 = Yes)	−0.053 (0.033)	−0.092 (0.104)	−0.061 (0.049)
Years sold to cooperative	−0.005 (0.009)	−0.0004 (0.029)	−0.004 (0.012)
Years sold * Additional income	0.001 (0.011)	−0.029 (0.036)	0.003 (0.016)
Constant	1.221** (0.140)	0.952* (0.437)	1.143** (0.186)
Game order, lottery position, lottery outcome controls	Y	Y	Y
Observations	124	124	88
R2	0.222	0.266	0.153

Notes: In column (2), the dependent variable is a dummy which equals 1 if the participant allocates the entire harvest to the certain-price buyer in all rounds; 0 otherwise. Column (3) presents the same regression as column (1) on the subset of participants for whom the dummy variable is 0. All three columns present heteroskedasticity-robust standard errors.
$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

this functionality using a mobile phone or tablet instead of tactile elements.

Finally, the allocation decisions of individual participants did not affect the outcomes of other participants. In real-life, a cooperative survives or fails on the basis of the joint decision of its members. Hopfensitz and Miquel-Florensa (2017) provides an example of an experiment in which cooperative member behavior varies depending on the behavior of non-members and the presence of a punishment mechanism for side-selling. Their work provides examples of elements that we could incorporate into a future experiment as well.

7 | Conclusion

In the past 30 years, many developing countries have shifted the way they support rural communities from a state-led approach to a market-led approach. As a result, agricultural cooperatives have emerged that offer many of the same services to their members in the present as state commodity boards in the past: a guaranteed purchase price, microcredit, and technical assistance. The big difference from state commodity boards is that agricultural cooperatives depend on the continued patronage of their producer members to finance their services. Weak institutions often prevent them from enforcing this condition. Moreover, many of the services like microcredit and technical assistance help members over the longrun, but because of liquidity constraints, members often seek to maximize profit over the shortrun. Thus, side-selling threatens cooperatives' ability to offer these services, and understanding the drivers of side-selling behavior is imperative for their continued existence.

We have presented the results of a framed field experiment that examines four possible determinants of side-selling behavior for indigenous coffee farmers in Mexico. The experiment abstracts the most important decision of many smallholder producers for their household economy: how much and to whom they market their cash crops. In our experiment, participants can market as much of their harvest as they like to each of a certain-price and an uncertain-price buyer. Unlike many previous studies, our experiment does not employ the distinction between the delayed payment of a cooperative and the immediate payment of a local trader. We also do not restrict participants' options in subsequent rounds based on their performance in the present round.

Our results extend beyond coffee and beyond Mexico. They provide several concrete policy recommendations to cooperatives to reduce the incidence of side-selling among their members. First, we find an overall lower incidence of side-selling (18%) than in many contexts, which confirms the preference of smallholder producers for price certainty. Since eliminating delayed payments reduces the incidence of side-selling, we encourage cooperatives to find upstream financing so that they can pay their members at the moment of delivery just like local traders.

Second, the incidence of side-selling is affected slightly by harvest size. This effect is consistent with the distinction between selling at the farmgate or at the market originally proposed by Fafchamps and Hill (2005). It means that cooperatives must be attentive to the fixed costs associated with the marketing decisions of their members and reduce or eliminate these fixed costs through the use of regional collection points or even visits to the farmgate.

Third, access to credit and technical assistance does not affect producer behavior in the short-term. However, in the medium-term, access to microcredit can help producers weather unexpected shocks. Moreover, in the long-term, technical assistance has the potential to dramatically improve producer yields. Liverpool-Tasie et al. (2020) point out that in a situation without formal contracts, cooperatives or producers may need subsidies to realize these long-term benefits.

Fourth, our additional income treatment confirmed the effectiveness of direct subsidies to producers. In the Mexican context, our subsidies are not infeasible; they are of the same magnitude as the conditional cash transfer programs of the past and present. The moderated treatment effects that we find suggest that these subsidies would be especially effective in ensuring the loyalty of cooperative members in the early years of their membership.

Finally, cooperatives need to find mechanisms to enforce sanctions on members who do not market their harvest through the cooperative. Michler and Wu (2020) provides a framework for relational contracts in contexts without formal contract enforcement. Casaburi and Macchiavello (2015) suggest that the mere threat of sanctions may be as effective as sanctions themselves.

Governments and non-governmental organizations alike implemented market-based reforms with great enthusiasm and promise. Several decades later, they still face challenges in realizing their potential in improving the welfare of smallholder producers. The results we present here suggest a few incremental improvements to improve their effectiveness and long-term sustainability.

Acknowledgments

We thank Marc Bellemare, Michael Boland, James Campbell, Jason Kerwin, Nicholas Magnan, Subha Mani, Jacob Ricker-Gilbert, David Rosenkranz, Andrew Simons, and three anonymous reviewers. We also thank participants in the Association for Economic Research of Indigenous Peoples seminar; seminars at Fordham University, Boston College, and Loyola University Chicago; and the invited poster session of the AAEA 2023 Annual Meetings in Washington, DC. We are grateful for funding from the Center for International Food and Agriculture Policy in the Department of Applied Economics at the University of Minnesota. We obtained IRB approval through the University of Minnesota (IRB ID STUDY00016085). All errors are our own.

Endnotes

[1] Thanks to an anonymous reviewer for suggesting that we frame the paper in this way.

[2] Thanks to Marc Bellemare for pointing out that technically the uncertain-price buyer is a risky price buyer since the distribution of the outside buyer price is known.

[3] We are grateful to the lead article in a special issue of *Food Policy* for this distinction (Markelova et al. 2009).

[4] Wright et al. (2024) provides a recent systematic review of the literature on coffee supply chains at the global level.

[5] This profile comes from previous work in this region by Pitts (2019).

[6] In many cooperatives, additional profits above and beyond the price paid for members' production are distributed to members at the end of the fiscal year. These additional payments are called patronage refunds. This feature sets cooperatives apart from investor-owned firms (IOFs), which distribute profits to shareholders at the end of the fiscal year.

[7] Because of enumerator error, 40 participants did not complete the practice game. We include it as a control in the regressions.

[8] An anonymous reviewer raised the concern that adding two elements at the same time in Game 3 to the framing in Game 2 conflates the preference for technical assistance and for cooperatives. In this context, only cooperatives provide technical assistance. However, future work could vary these attributes separately.

[9] A quintal is a local unit that corresponds to 60 kg of green coffee.

[10] Appendix A contains all 12 possible payoff tables.

[11] Appendix A contains the entire survey.

[12] At the request of an anonymous reviewer, we estimated two alternative specifications of Equation (3): one that omitted this time trend and another that replaced it with round fixed effects. The results of these alternative specifications were nearly identical to the results of our preferred specification.

[13] Thanks to David Rosenkranz for pointing this out.

[14] For example, the Bayesian adaptive choice experiment software developed by Drake et al. (2024).

[15] Enumerators read from a standardized script.

References

Alemu, D., A. Guinan, and J. Hermanson. 2021. "Contract Farming, Cooperatives and Challenges of Side Selling: Malt Barley Value-Chain Development in Ethiopia." *Development in Practice* 31, no. 4: 496–510. https://doi.org/10.1080/09614524.2020.1860194.

Arana-Coronado, J. J., C. O. Trejo-Pech, M. Velandia, and J. Peralta-Jimenez. 2019. "Factors Influencing Organic and Fair Trade Coffee Growers Level of Engagement With Cooperatives: The Case of Coffee Farmers in Mexico." *Journal of International Food & Agribusiness Marketing* 31, no. 1: 22–51. https://doi.org/10.1080/08974438.2018.1471637.

Barrett, C. B. 1996. "On Price Risk and the Inverse Farm Size-Productivity Relationship." *Journal of Development Economics* 51, no. 2: 193–215. https://doi.org/10.1016/S0304-3878(96)00412-9.

Bellemare, M. F., C. B. Barrett, and D. R. Just. 2013. "The Welfare Impacts of Commodity Price Volatility: Evidence From Rural Ethiopia." *American Journal of Agricultural Economics* 95, no. 4: 877–899. https://doi.org/10.1093/ajae/aat018.

Bellemare, M. F., Y. N. Lee, and D. R. Just. 2020. "Producer Attitudes Toward Output Price Risk: Experimental Evidence From the Lab and From the Field." *American Journal of Agricultural Economics* 102, no. 3: 806–825. https://doi.org/10.1002/ajae.12004.

Bellemare, M. F., Y. N. Lee, and L. Novak. 2021. "Contract Farming as Partial Insurance." *World Development* 140: 105274. https://doi.org/10.1016/j.worlddev.2020.105274.

Bernard, T., and D. J. Spielman. 2009. "Reaching the Rural Poor Through Rural Producer Organizations? A Study of Agricultural Marketing Cooperatives in Ethiopia." *Food Policy* 34, no. 1: 60–69. https://doi.org/10.1016/j.foodpol.2008.08.001.

Bhuyan, S. 2007. "The "People" Factor in Cooperatives: An Analysis of Members' Attitudes and Behavior." *Canadian Journal of Agricultural Economics* 55, no. 3: 275–298. https://doi.org/10.1111/j.1744-7976.2007.00092.x.

Binswanger, H. P. 1980. "Attitudes Toward Risk: Experimental Measurement in Rural India." *American Journal of Agricultural Economics* 62, no. 3: 395–407. https://doi.org/10.2307/1240194.

Bobrow-Strain, A. 2007. *Intimate Enemies: Landowners, Power, and Violence in Chiapas*. Duke University Press.

Boyd, C. M., and M. F. Bellemare. 2020. "The Microeconomics of Agricultural Price Risk." *Annual Review of Resource Economics* 12, no. 1: 149–169. https://doi.org/10.1146/annurev-resource-100518-093807.

Boyd, C. M., and M. F. Bellemare. 2022. "Why Not Insure Prices? Experimental Evidence From Peru." *Journal of Economic Behavior & Organization* 202: 580–631. https://doi.org/10.1016/j.jebo.2022.08.004.

Caputo, V., and D. R. Just. 2022. "The Economics of Food Related Policies: Considering Public Health and malnutrition." In *Handbook of Agricultural Economics*, edited by C. Barrett and D. Just, 5117–5200. Elsevier. https://doi.org/10.1016/bs.hesagr.2022.03.008.

Cardenas, J. C., and J. Carpenter. 2013. "Risk Attitudes and Economic Well-Being in Latin America." *Journal of Development Economics* 103: 52–61. https://doi.org/10.1016/j.jdeveco.2013.01.008.

Casaburi, L., and R. Macchiavello. 2015. "Loyalty, Exit, and Enforcement: Evidence From a Kenya Dairy Cooperative." *American Economic Review* 105, no. 5: 286–290. https://doi.org/10.1257/aer.p20151076.

Casaburi, L., and T. Reed. 2022. "Using Individual-Level Randomized Treatment to Learn About Market Structure." *American Economic Journal: Applied Economics* 14, no. 4: 58–90. https://doi.org/10.1257/app.20200306.

Charness, G., U. Gneezy, and A. Imas. 2013. "Experimental Methods: Eliciting Risk Preferences." *Journal of Economic Behavior & Organization* 87: 43–51. https://doi.org/10.1016/j.jebo.2012.12.023.

Dragusanu, R., D. Giovannucci, and N. Nunn. 2014. "The Economics of Fair Trade." *Journal of Economic Perspectives* 28, no. 3: 217–236. https://doi.org/10.1257/jep.28.3.217.

Drake, M., F. Payró, N. Thakral, and L. T. Tô. 2024. Bayesian Adaptive Choice Experiments. https://linh.to/files/papers/bace.pdf.

Eckel, C. C., and P. J. Grossman. 2008. "Men, Women and Risk Aversion: Experimental Evidence." In *Handbook of Experimental Economics Results*, edited by C. R. Plott and V. L. Smith, 1061–1073. Elsevier. https://doi.org/10.1016/S1574-0722(07)00113-8.

Eckel, C. C., and N. C. Londono. 2021. "How to Tame Lab-in-the-Field Experiments." In *Advances in Experimental Political Science*, edited by D. P. Green and J. N. Druckman, 79–102. Cambridge University Press. https://doi.org/10.1017/9781108777919.007.

Ewusi Koomson, J., E. Donkor, and V. Owusu. 2022. "Contract Farming Scheme for Rubber Production in Western Region of Ghana: Why Do Farmers Side Sell?" *Forests, Trees and Livelihoods* 31, no. 3: 139–152. https://doi.org/10.1080/14728028.2022.2079007.

Fafchamps, M., and R. V. Hill. 2005. "Selling at the Farmgate or Traveling to Market." *American Journal of Agricultural Economics* 87, no. 3: 717–734. https://doi.org/10.1111/j.1467-8276.2005.00758.x.

Finkelshtain, I., and J. A. Chalfant. 1991. "Marketed Surplus Under Risk: Do Peasants Agree With Sandmo?" *American Journal of Agricultural Economics* 73, no. 3: 557–567. https://doi.org/10.2307/1242809.

Fischer, E., and M. Qaim. 2014. "Smallholder Farmers and Collective Action: What Determines the Intensity of Participation?" *Journal of Agricultural Economics* 65, no. 3: 683–702. https://doi.org/10.1111/1477-9552.12060.

Folch, A., and J. Planas. 2019. "Cooperation, Fair Trade, and the Development of Organic Coffee Growing in Chiapas (1980–2015)." *Sustainability* 11, no. 2: 357. https://doi.org/10.3390/su11020357.

Frijters, P., T. S. Kong, and E. M. Liu. 2015. "Who Is Coming to the Artefactual Field Experiment? Participation Bias Among Chinese Rural Migrants." *Journal of Economic Behavior & Organization* 114: 62–74. https://doi.org/10.1016/j.jebo.2015.03.006.

Geng, X., W. Janssens, and B. Kramer. 2023. "Liquid Milk: Savings, Insurance and Side-Selling in Cooperatives." *Journal of Development Economics* 165: 103142. https://doi.org/10.1016/j.jdeveco.2023.103142.

Gerard, A., M. C. Lopez, D. C. Clay, and D. L. Ortega. 2021. "Farmer Cooperatives, Gender and Side-Selling Behavior in Burundi's Coffee Sector." *Journal of Agribusiness in Developing and Emerging Economies* 11, no. 5: 490–505. https://doi.org/10.1108/JADEE-05-2020-0081.

Harrison, G. W., and J. A. List. 2004. "Field Experiments." *Journal of Economic Literature* 42, no. 4: 1009–1055. https://doi.org/10.1257/0022051043004577.

Holt, C. A., and S. K. Laury. 2002. "Risk Aversion and Incentive Effects." *American Economic Review* 92, no. 5: 1644–1655. https://doi.org/10.1257/000282802762024700.

Hopfensitz, A., and J. Miquel-Florensa. 2017. "Mill Ownership and Farmer's Cooperative Behavior: The Case of Costa Rica Coffee Farmers." *Journal of Institutional Economics* 13, no. 3: 623–648. https://doi.org/10.1017/S1744137416000527.

Keenan, M., R. Fort, and R. Vargas. 2024. "Shocked Into Side-Selling? Production Shocks and Organic Coffee Farmers' Marketing Decisions." *Food Policy* 125: 102631. https://doi.org/10.1016/j.foodpol.2024.102631.

Klein, K. K., T. J. Richards, and A. Walburger. 1997. "Determinants of Co-Operative Patronage in Alberta." *Canadian Journal of Agricultural Economics* 45, no. 2: 93–110. https://doi.org/10.1111/j.1744-7976.1997.tb00195.x.

Liverpool-Tasie, L. S. O., A. Wineman, S. Young, et al. 2020. "A Scoping Review of Market Links Between Value Chain Actors and Small-Scale Producers in Developing Regions." *Nature Sustainability* 3, no. 10: 799–808. https://doi.org/10.1038/s41893-020-00621-2.

Macchiavello, R., and A. Morjaria. 2015. "The Value of Relationships: Evidence From a Supply Shock to Kenyan Rose Exports." *American Economic Review* 105, no. 9: 2911–2945. https://doi.org/10.1257/aer.20120141.

Markelova, H., R. Meinzen-Dick, J. Hellin, and S. Dohrn. 2009. "Collective Action for Smallholder Market Access." *Food Policy* 34, no. 1: 1–7. https://doi.org/10.1016/j.foodpol.2008.10.001.

Mattos, F. L., and J. Zinn. 2016. "Formation and Adaptation of Reference Prices in Grain Marketing: An Experimental Study." *Agricultural Economics* 47, no. 6: 621–632. https://doi.org/10.1111/agec.12260.

Michler, J. D., and S. Y. Wu. 2020. "Relational Contracts in Agriculture: Theory and Evidence." *Annual Review of Resource Economics* 12, no. 1: 111–127. https://doi.org/10.1146/annurev-resource-101719-034514.

Mojo, D., C. Fischer, and T. Degefa. 2017. "The Determinants and Economic Impacts of Membership in Coffee Farmer Cooperatives: Recent Evidence From Rural Ethiopia." *Journal of Rural Studies* 50: 84–94. https://doi.org/10.1016/j.jrurstud.2016.12.010.

Moya, A. 2018. "Violence, Psychological Trauma, and Risk Attitudes: Evidence From Victims of Violence in Colombia." *Journal of Development Economics* 131: 15–27. https://doi.org/10.1016/j.jdeveco.2017.11.001.

Mujawamariya, G., M. D'Haese, and S. Speelman. 2013. "Exploring Double Side-Selling in Cooperatives, Case Study of Four Coffee Cooperatives in Rwanda." *Food Policy* 39: 72–83. https://doi.org/10.1016/j.foodpol.2012.12.008.

Newbery, D. M. G., and J. E. Stiglitz. 1981. *The Theory of Commodity Price Stabilization: A Study in the Economics of Risk*. Clarendon Press.

Nyamamba, J. S., O. I. Ayuya, and K. W. Sibiko. 2022. "Determinants of Side Selling Behaviour in Emerging Sorghum Supply Chains in Kisumu County, Kenya." *Cogent Economics & Finance* 10, no. 1: 1986932. https://doi.org/10.1080/23322039.2021.1986932.

Palm-Forster, L. H., and K. D. Messer. 2021. "Experimental and Behavioral Economics to Inform Agri-environmental Programs and policies." In *Handbook of Agricultural Economics*, edited by C. B. Barrett and D. R. Just, 4331–4406. Elsevier. https://doi.org/10.1016/bs.hesagr.2021.10.006.

Papke, L. E., and J. M. Wooldridge. 1996. "Econometric Methods for Fractional Response Variables With an Application to 401 (K) Plan Participation Rates." *Journal of Applied Econometrics* 11, no. 6: 619–632. https://doi.org/10.1002/(SICI)1099-1255(199611)11:6(619::AID-JAE418)3.0.CO;2-1.

Pfeiffer, L., A. López-Feldman, and J. E. Taylor. 2009. "Is Off-Farm Income Reforming the Farm? Evidence From Mexico." *Agricultural Economics* 40, no. 2: 125–138. https://doi.org/10.1111/j.1574-0862.2009.00365.x.

Pitts, S. 2019. "Value Chain Integration as an Alternative to Fair Trade for Chiapas Coffee Farmers." In *Entrepreneurship and Development in the 21st Century*, edited by B. S. Sergi and C. C. Scanlon, 103–138. Emerald Publishing Limited. https://doi.org/10.1108/978-1-78973-233-720191007.

Pitts, S. (2019). "The Role of the Farmer and Their Cooperative in Supply Chain Governance: A Latin American Small Producer perspective." In *Handbook of Research on Cooperatives and Mutuals*, 172–184. Edward Elgar Publishing. Retrieved November 29, 2024, from https://www.elgaronline.com/edcollchap/book/9781802202618/book-part-9781802202618–19.xml.

Reglas de Operación del Programa Sembrando Vida. 2022, December 30. Secretaria de Bienestar. Retrieved October 9, 2023, from https://www.gob.mx/cms/uploads/attachment/file/788907/SV2023_DOF.pdf.

Renard, M.-C., and M. O. Breña. 2010. "The Mexican Coffee Crisis." *Latin American Perspectives* 37, no. 2: 21–33. https://doi.org/10.1177/0094582×09356956.

Sandmo, A. 1971. "On the Theory of the Competitive Firm Under Price Uncertainty." *American Economic Review* 61, no. 1: 65–73.

Shumeta, Z., M. D'Haese, and W. Verbeke. 2018. "A Two-Step Econometric Estimation of Covariates of Side Selling: The Case of Coffee Cooperatives in Southwest Ethiopia." *Journal of Development Studies* 54, no. 10: 1775–1791. https://doi.org/10.1080/00220388.2017.1324146.

Woldeyohanes, T., T. Heckelei, and Y. Surry. 2017. "Effect of Off-Farm Income on Smallholder Commercialization: Panel Evidence From Rural Households in Ethiopia." *Agricultural Economics* 48, no. 2: 207–218. https://doi.org/10.1111/agec.12327.

Woldie, G. A. 2010. "Optimal Farmer Choice of Marketing Channels in the Ethiopian Banana Market." *Journal of Agricultural & Food Industrial Organization* 8, no. 1: Article 7. https://doi.org/10.2202/1542-0485.1298.

Wollni, M., and E. Fischer. 2015. "Member Deliveries in Collective Marketing Relationships: Evidence From Coffee Cooperatives in Costa Rica." *European Review of Agricultural Economics* 42, no. 2: 287–314. https://doi.org/10.1093/erae/jbu023.

Wright, D. R., S. A. Bekessy, P. E. Lentini, et al. 2024. "Sustainable Coffee: A Review of the Diverse Initiatives and Governance Dimensions of Global Coffee Supply Chains." *Ambio* 53, no. 7: 984–1001. https://doi.org/10.1007/s13280-024-02003-w.

Wuepper, D., S. Bukchin-Peles, D. Just, and D. Zilberman. 2023. "Behavioral Agricultural Economics." *Applied Economic Perspectives and Policy* 45, no. 4: 1–12. https://doi.org/10.1002/aepp.13343.

Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting Appendix A: Experimental Protocol.

Supporting Figure A1: Lottery Table shown to Participants.

Supporting Figure A2: Scenario 1.

Supporting Figure A3: Scenario 2.

Supporting Figure A4: Scenario 3.

Supporting Figure A5: Profit Table for 2 quintal harvest, Buyer 2 Scenario 1.

Supporting Figure A6: Profit Table for 2 quintal harvest, Buyer 2 Scenario 2.

Supporting Figure A7: Profit Table for 2 quintal harvest, Buyer 2 Scenario 3.

Supporting Figure A8: Profit Table for 4 quintal harvest, Buyer 2 Scenario 1.

Supporting Figure A9: Profit Table for 4 quintal harvest, Buyer 2 Scenario 2.

Supporting Figure A10: Profit Table for 4 quintal harvest, Buyer 2 Scenario 3.

Supporting Figure A11: Profit Table for 6 quintal harvest, Buyer 2 Scenario 1.

Supporting Figure A12: Profit Table for 6 quintal harvest, Buyer 2 Scenario 2.

Supporting Figure A13: Profit Table for 6 quintal harvest, Buyer 2 Scenario 3.

Supporting Figure A14: Profit Table for 8 quintal harvest, Buyer 2 Scenario 1.

Supporting Figure A15: Profit Table for 8 quintal harvest, Buyer 2 Scenario 2.

Supporting Figure A16: Profit Table for 8 quintal harvest, Buyer 2 Scenario 3

Supporting Information: ms2024035_replication