Impact of Market Information on Cashew Producers in Guinea-Bissau.

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Abstract

Does lack of information reduce the ability of producers to find the right time to sell their products? To answer this question, we ran a two-level cluster randomized control trial among 1988 cashew producers in 290 villages in Guinea-Bissau. Treated producers received weekly messages to their mobiles during the trading season in 2020. The messages provided up-to-date market news, farmgate prices, and gave marketing advice. We found that treated producers sold their cashews more frequently relative to the producers in other experimental groups, who tend to sell their cashews in a single transaction. Treated producers failed to earn higher prices, but earned 21% more from all sales and barters, relative to the control group mean. We explore several mechanisms to understand our results. We found no evidence suggesting that treated producers changed their buyers, the location of their sales, had more bargaining power, better record keeping, or different attitudes towards risk. Given the low cost of our intervention, market information can be a cost-effective tool to increase producers' revenues.

Keywords: Economic Development; International Linkages to Development; Role of International Organizations; Agricultural Markets and Marketing

JEL Classification: O13, O19, Q13

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I. Introduction

Economic theories often rely on the assumption that agents have perfect information when making their decisions. When markets are geographically dispersed and lack good infrastructure, however, reliable and up-to-date information may be costly or limited. In these contexts, imperfect information may affect choices and result in inefficient market outcomes (Allen, 2014). Information communication technologies can improve market performance by increasing the availability of information (e.g., Fabregas, Kremer & Schilbach, 2019; Aker & Mbiti, 2010; Casaburi, Glennerster & Suri, 2013).

This article seeks to understand whether and how information technologies affect market outcomes. Our study was based in Guinea-Bissau, where we worked with producers of cashew nuts, an export crop with high price volatility. We evaluate the effect of providing cashew producers with timely and reliable market information through weekly voice messages during the 2020 trading season. Specifically, we provided producers with information on market trends, prices and marketing advice during the post-harvest trading period, introducing a new market information system in the country.[1]

We implemented a two-level cluster randomized control trial, randomizing treatment assignment both across and within villages. In treated villages, a randomly selected group of cashew producers received free weekly market information between April and October 2020 via voice and text messages to their mobile phones. These messages were tailored to be easy to understand and to provide producers with up-to-date market news, ranges of farmgate prices across the country, and marketing advice based on likely market trends. Because there were both treated and untreated producers in treated villages, our research design also allowed us to estimate within-village spillover effects. During the period of our intervention, these messages were only accessible to treated producers in the country.

We evaluated this intervention during the 2020 trading season by analyzing a set

[1] We introduced the *n'kalô* service to Guinea-Bissau. *N'kalô* is a market information system designed by the French NGO Nitidae, which operates in several cashew-producing countries and is a globally trusted source of information for this commodity market.

of outcomes collected during in-person interviews between April and May 2021. The timing of these interviews coincided with the initial weeks of the 2021 trading season.[2] Our analysis plan was registered before we completed these in-person interviews.[3]

Our results show that treated producers sold their cashews more frequently relative to other experimental groups during the 2020 trading season. Most producers earned their annual revenue from selling their production in one or two transactions. Because cashew prices fluctuate during the trading season, the timing of these transactions matters.[4] Treated producers failed to earn higher prices but earned 21% higher revenue from all sales and barters relative to the control group mean. We found some evidence to suggest that untreated producers living in villages with other treated producers also benefited from the intervention. Interestingly, the spillover group of untreated producers in treated villages appeared to earn higher revenue from barter exchanges than from monetary sales. Treated producers were marginally more likely to share information about prices, which may explain how spillovers occurred.

We were able to rule out several potential mechanisms that may have driven our results. First, we found no evidence that producers changed where or to whom they sold their cashew nuts. In our context and at the time of our intervention, which coincided with the onset of the COVID-19 pandemic, it may have been challenging for producers to sell their stocks outside of their villages.[5] Second, we found no evidence to suggest that treated producers had more bargaining power, and we found only weak evidence that treated producers had a more realistic outlook on prices for the upcoming trading season. Third, we were also able to rule out the possibility that our effects resulted from the better record-keeping induced by our intervention or by changes in preference parameters, such as risk aversion. However, we did find some weak evidence that treated producers reported higher levels of trust relative to producers in other experimental groups.

[2] The intervention is described in Section 3.1.
[3] See https://www.socialscienceregistry.org/trials/4740 for the trial registration and analysis plan.
[4] Every year, producers sell their cashews in the trading season after harvest, with no storage across years.
[5] In Appendix Table 5, we provide more details on the differences between the 2019 and 2020 commercialization seasons to describe the overall changes that occurred at the onset of the COVID-19 pandemic.

Our contribution to the literature on agricultural commodity markets is to show that imperfect information limits the scope of intertemporal arbitrage. Information frictions could be both spatial and temporal. Producers might lack information on both *where* and when to sell their output to maximize profits. Previous studies have shown that, with the introduction of new information technologies, producers have been better able to decide *where* to sell (Aker, 2010; Jensen, 2007). Instead, our study shows that producers may also lack information on *when* it is better to sell and how much to sell at different points in time. Credit or storage constraints may prevent producers from selling at the optimal time (Burke, Bergquist & Miguel, 2019; Aggarwal, Francis & Robinson, 2018; Kadjo et al., 2018). But, to our knowledge, we are the first to causally document how information frictions limit the scope of intertemporal arbitrage in commodity markets. Earlier studies in this literature relied on non-experimental data to look at the effects of information on market performance over time (Osborne, 2004; Fafchamps & Hill, 2008).

Our study complements the literature on the use of information communication technologies in agriculture (see Nakasone, Torero & Minten, 2014 or Aker, Ghosh & Burrell, 2016) for reviews of this literature).

We build upon previous evaluations of market information systems, which have found mixed results on the benefits of these services to farmers.[6] Our intervention differs from these evaluations in three ways: First, we are the first to evaluate a market information system that disseminated price information via audio messages (through robocalls and an interactive voice-response system) as opposed to text-based messages. This novel means of communication was intended to address the barriers that users with low literacy may have faced in interpreting the information they received, which previous studies have identified as a potential explanation for the lack of positive effects

[6] Randomized evaluations of MIS in Colombia (Camacho & Conover, 2019) and India (Fafchamps & Minten, 2012); Mitra et al. (2018) have failed to find a significant average treatment effect on producer prices. In contrast, Svensson and Yanagizawa (2009) and Hildebrandt et al. (2021) found that MIS in Uganda and Ghana, respectively, increased producer prices by 7-10% for specific crops. In a related intervention, Goyal (2010) studied the expansion of information kiosks in district markets in Andhra Pradesh and found that the kiosks increased producer prices by about 1-3%.

(Fafchamps & Minten, 2012).[7] Second, our messages provided not only a point estimate for the wholesale market price, as in Mitra et al. (2018) but also a range of farmgate prices for all regions in Guinea-Bissau. The messages also included market information on expected price developments and concrete marketing advice about when and at what price to sell production. Third, we focused on an export commodity, whose local price fluctuations are mostly driven by exogenous changes in international prices. Previous studies have not focused on export commodities but rather on internally consumed commodities.

This article is structured as follows. We begin by illustrating the main features of the market for cashew nuts that we study, briefly describing its supply chain (producers, intermediaries, and exporters), and the characteristics of the sample of producers we work with. In Section 3, we describe our intervention, our sampling and randomization protocol, and our estimation and inference strategy. Section 4 presents results on the main outcomes of interest collected during the endline survey. In Section 5, finally, we analyze a set of potential competing explanations for the underlying mechanisms of our main results.

II. Economic Context

Guinea-Bissau is a country located on the west coast of Africa with a surface area of 36,125 km^2 and a tropical climate conducive to cashew cultivation. In 2019, it was the fifth largest producer of raw cashew nuts in the world. In the last decades, the country's economy has been heavily dependent upon the production and commercialization of raw cashew nuts, which is the main export product representing more than 90% of the total official exports. In general, the demand for Guinea-Bissau cashew nuts, according

[7] Cole and Fernando (2021) studied an agricultural-extension service that informed Indian farmers of different production practices via audio-based messages, but they did not provide marketing advice or price information.

to statistics of the National Macroeconomic and Budgetary Framework Committee, is divided as follows: less than 10% goes to the domestic market (processing units) and, more than 90% is exported to the international market, mostly to India, Vietnam, and China.[8] The national cashew-nut market, as with many agricultural commodities, is particularly influenced by the dynamics of international supply and demand. However, as shown in Figure 1, the margins between export and farmgate prices are variable and large, which suggest that market imperfections may be reducing pass-through rates to producers.

In Guinea-Bissau, production of raw cashew nuts is atomized. At least 40% of households in the country are involved in cashew production, and about 85% of producers are smallholders. In the rest of this section, baseline data was used to characterize producers in this market. Details of the baseline survey are provided in the next section.

Our descriptive statistics, in Table 1, show that almost all producers in our sample were men (94%) who were 43 years old on average. Household size was large: the median household had twelve individuals; all producers lived in rural areas. The median producer had completed three years of education and had worked in the cashew sector for the previous nine years. About 30% of respondents were unable to read a basic sentence, suggesting that developing a service that takes into account low literacy skills would be important to increase take-up. The size of the median cashew plantation was around 3.4 hectares.[9] About two thirds of our respondents reported having no difficulties storing their cashew production.

Sales

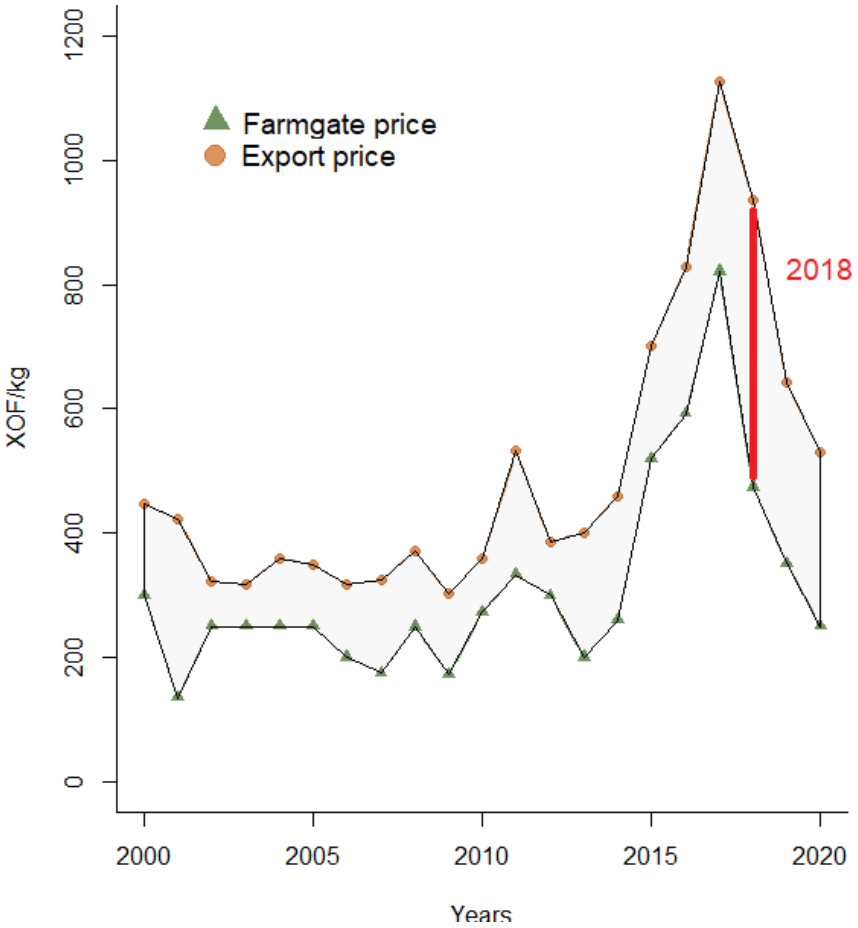
Most producers reported that they concentrated their sales into a single trade, as shown in Table 1. The median number of potential buyers was two, but the median number of sales was just one. This finding has important implications. Because these

[8] Although most of the production is exported as raw cashew nuts, there are also exports of processed nuts. A small portion of cashew nuts are consumed domestically, but the most dynamic and profitable markets are in high-income countries that import.

[9] Appendix Table 3 briefly describes the costs involved in cashew production, which are mostly related to labor.

sales provide the largest share of their annual income, the decision regarding when to sell has high-stakes for the majority of producers. For 80% of our sample, cashew sales constituted the primary source of income.

Figure 1: Margin between Export and Farmgate Prices across Years



Source: Directorate for Macroeconomic Forecasting, Ministry of Economy and Finance of Guinea-Bissau. Raw cashew nut prices per kg reported in nominal West African CFA francs (XOF). Export prices are free-on-board average prices from the Bissau port collected by the Ministry of Commerce, and farmgate prices are national averages collected by the National Statistics Institute.

The average reported farmgate price across all sales averaged 390 West African CFA francs (XOF)/kg, significantly below the reference price of 500 XOF/kg that the government had proposed at the beginning of the 2019 trading season.[10] However, 38% of respondents stated they believed the government reference price to be an important

[10] All monetary values are reported in nominal West African CFA francs (XOF), which were pegged to the euro at an exchange rate of 1 EU for 656 XOF.

factor in their sales decisions.

Spatial arbitrage is rare in this market: 97% of sales occurred at the producer's house or somewhere else in the producer's village. Producers rarely travelled with their output to other markets because doing so exposed them to increased risks and costs. Most did not have a network of potential buyers beyond their villages.[11] Fifty-four percent of buyers were traders who temporarily visited the villages, while 39% were intermediaries that lived regularly in the same village as producers. In our sample, around 4% of producers reported acting as intermediaries, buying from other producers and selling quantities that ranged between two and twenty metric tons to other traders (i.e., much larger than what individual producers sell on average). More than half of respondents relied mostly on family and friends for commercialization advice, with only a few producers relying on more formal channels such as producer associations. Of those who asked for advice, information regarding the timing of sales (in addition to the right price) was most frequently sought. Only 6% of producers in our sample had heard of the market information system launched by a previous World Bank-financed project but later discontinued.

[11] According to qualitative interviews implemented in some of the villages in our sample.

Table 1: Sample characteristics at baseline

	Mean	St. Dev.	Min	25th percentile	Median	75th percentile	Max
Individual-level characteristics:							
1 if a woman	0.06	0.23	0.00	0.00	0.00	0.00	1.00
Age	42.91	14.53	16.00	32.00	41.00	52.00	94.00
Household size	13.66	8.16	1.00	8.00	12.00	17.00	86.00
Years of education	3.95	3.85	0.00	0.00	3.00	6.00	15.00
Years of experience in cashew sector	10.41	7.11	1.00	5.00	9.00	15.00	42.00
1 if can read	0.29	0.45	0.00	0.00	0.00	1.00	1.00
Area plantation (hectares)	3.45	2.58	0.10	2.00	3.00	4.00	25.00
1 if faces storage limitations	0.31	0.46	0.00	0.00	0.00	1.00	1.00
Number of sales	1.64	0.79	0.00	1.00	1.00	2.00	6.00
Number of potential buyers that made offers	2.82	1.77	0.00	1.00	2.00	4.00	13.00
1 if cashews are the main source of income	0.80	0.40	0.00	1.00	1.00	1.00	1.00
Price per sale per kg (XOF)	390.92	100.58	0.00	332.18	370.94	450.00	1000.00
1 if thinks that the reference price is important	0.38	0.48	0.00	0.00	0.00	1.00	1.00
1 if sold cashews in their own village	0.97	0.17	0.00	1.00	1.00	1.00	1.00
1 if sold most to local buyer	0.39	0.49	0.00	0.00	0.00	1.00	1.00
1 if sold most to itinerant buyer	0.54	0.50	0.00	0.00	1.00	1.00	1.00
1 if acted as intermediary	0.04	0.18	0.00	0.00	0.00	0.00	1.00
1 if sourced market information from family	0.57	0.50	0.00	0.00	1.00	1.00	1.00
1 if sourced information on best time to sell	0.54	0.50	0.00	0.00	1.00	1.00	1.00
1 if heard of mobile MIS	0.06	0.24	0.00	0.00	0.00	0.00	1.00
Total quantity produced (kg)	1526.59	1627.36	0.00	669.50	1125.00	1935.00	33830.00
1 if borrowed money or rice	0.35	0.48	0.00	0.00	0.00	1.00	1.00
1 if exchanged cashew for rice	0.34	0.47	0.00	0.00	0.00	1.00	1.00
Total quantity exchanged (kg)	146.73	303.85	0.00	0.00	0.00	180.00	2700.00
Total quantity paid for loans (kg)	54.43	175.52	0.00	0.00	0.00	45.00	3750.00
Village-level characteristics:							
Number of cashew producers in the village	32.39	24.19	4.00	17.00	24.00	40.50	177.00
Number of cashew buyers in the village	3.56	3.39	0.00	1.00	3.00	5.00	20.00
Road distance in km to nearest sector capital	28.12	23.09	0.33	10.92	22.11	37.58	123.96
Road distance in km to nearest region capital	51.69	33.71	3.29	26.43	46.29	67.19	188.02
Road distance in km to the capital	159.43	68.46	32.08	101.46	155.34	213.46	298.74
Observations	1988						

Rice Exchanges and Interlinked Contracts

Many producers exchange their cashews in return for rice or to obtain loans to pay for their immediate needs. While technically illegal (according to national legislation), in-kind exchanges and loans of rice are common and represent an important margin in the marketing decisions of producers in this market. In our baseline sample, 35% of the producers had bartered cashews for rice and 34% had borrowed money or rice in exchange for cashews. The quantities involved in these transactions were generally a relatively small fraction of overall production for most producers. In 2019, the average producer reported producing about 1,500 kg of cashews. In 2019, we estimate that, on average, 13% of marketable production was used for barters with rice or loans. The majority of these informal loans were reported to take place in the months preceding the trading season (November to January), when producers are most liquidity-constrained.

These interlinked contracts reduce the ability of producers to pick a better time during the trading season to sell their production. However, even those that took up a loan (in-kind or in-cash) still made sales during the trading season.

Village Characteristics

The villages in our study were all in relatively remote rural areas. The median village had twenty-four cashew producers and three buyers who lived in the village. They were relatively distant from markets. The median village was 22 km away from the closest sector capital, 46 km from the closest regional capital, and 155 km away from the country's capital, Bissau, where most raw cashew nuts are exported from.[12]

COVID-19 in Guinea-Bissau and the 2020 Cashew Marketing Season

The global surge of COVID-19 in the first quarter of 2020 occurred during the run-up to the cashew-trading season in Guinea-Bissau, and a combination of international and local factors substantially affected market conditions.

Internationally, the two largest importers of raw cashew nuts, India and Vietnam, had already closed their borders and cashew-processing plants when Guinea-Bissau confirmed its first two positive cases of COVID-19 on March 25, 2020. Even though demand for processed cashews remained high in the first half of 2020, this disruption in the supply chain caused a substantial slump in international demand for raw cashew nuts. Sales in other cashew-producing countries in West Africa came to a near-complete halt as border closures all over the world brought additional market uncertainty. Authorities in Guinea-Bissau closed air and land borders as part of their preventive measures to reduce the spread of COVID-19, preventing international and regional cashew value-chain agents, mostly buyers and intermediaries, from entering Guinea-Bissau and also reducing the influx of capital needed to buy raw cashew from producers. National travel restrictions between regions also limited the movement of seasonal workers who

[12] Guinea-Bissau is administratively divided into nine regions, including a semi-urban region for the capital, Bissau. Regions are sub-divided into sectors, which are smaller administrative units. There are on average four sectors per region.

supported the labor-intensive collection of cashew nuts.

In this context, the government delayed the start of the official marketing season, which typically starts by the end of March, until May 27. While trade between producers and intermediaries does take place before the official start of the season, it is technically unlawful, and demand for raw cashew nuts generally increases substantially once legal trading is opened by the government.

In our sample, we found that decreases in both farmgate prices and quantity produced resulted in a 47% decrease in producers' average revenue from cashew from 2019 to 2020.[13] The introduction of the *n'kalô* service and the impact evaluation reported in this paper took place in a particularly difficult year for cashew producers. For more details about their differential performance in 2019 and 2020 please see Appendix A.5.

III. Study Design, Data, and Empirical Strategy

3.1. Intervention: a Mobile Market Information System

Our intervention provided market information to cashew producers in Guinea-Bissau during the marketing season, via weekly short text messages or robocalls between April and August 2020.[14]

The market information delivered through those weekly messages consisted of: (i) the current range of farmgate raw cashew nut prices across regions in Guinea-Bissau, (ii) important news about the market, and (iii) sales advice based on expected market

[13] We estimated this difference using data for producers alone in the control group.
[14] The 2020 marketing season started on May 27, two months after what would have been the usual start of the season. The delay was a result of COVID-19 and a contested presidential election held in December 2019. However, small trades of cashews were recorded from a number of buyers starting in March 2020.

trends.[15]

As a part of the intervention, our research team provided randomly selected producers with a one-hour training on the main factors determining the farmgate price and how receiving our weekly messages could improve their sales decisions. The research team provided the training on the same day of the baseline survey, shortly after the baseline interview took place.

Our weekly short text messages were sent to those randomly selected producers between the 1st of April and the 8th of May. From the 16th of May, the weekly messages were sent via robocalls.[16] Finally, since the 26th of June, the information was also available on demand, as the audio content of the weekly robocalls could be accessed using an interactive voice response service.[17] Figure 4 shows the number of robocalls received by the treated producers during the 2020 season. The median treated producer received at least 8 messages through either SMS or robocalls.

3.2. Sampling

Village-Level Sampling

Our sampling strategy had two main goals: (i) making the treatment and control groups statistically balanced across a set of baseline characteristics, and (ii) minimizing spillovers of the treatment to untreated villages. There is a trade-off between these two goals: minimizing spillovers requires that treatment and control groups be sufficiently far apart geographically; while statistical balance requires that treatment and control groups

[15] The content of the messages was developed weekly, in line with the methodology of the *n'kalô* service, a market information system already operating in other West African countries, which we introduced to Guinea-Bissau in collaboration with the Ministry of Finance. See the whole list of messages and the date in which they were sent in Appendix Table 20.

[16] Section 3.3 details our randomization strategy.

[17] Because of delays associated with COVID-19 and with the implementing mobile operator, MTN, the interactive voice response service was active for only two months prior to the end of the season. Our original plan was to develop the service before the start of the 2020 season. According to our original plan, we would have had two separate treatment arms, with the first one receiving the service for free and the other one only after subscribing to it for a small monthly price. Given the delay in setting up the interactive voice response service, we decided to merge these two treatment arms into one and to provide the service for free to every treated producer.

be similar to each other, which is in turn often requires geographical proximity (Duflo, Glennerster & Kremer, 2008). We address this trade-off as follows.

In order to select villages for our study, we created a grid containing 2.7 km^2 cells, covering the entirety of the country. We sampled 290 villages from about 1,800 villages, using geocoded census data, such that one village was chosen from each cell.[18] For each village, we computed the closest distance to another sampled village. We stored the value of the minimum distance in the sample of villages drawn. We repeated these steps 999 times and choose the sample that had the largest minimum distance.

We excluded from our sampling frame villages that had the following characteristics:

- fewer than ten households according to the 2009 census (to allow a sufficiently large sample of cashew producers in every village),
- located on the islands (because of budget constraints),
- located within a radius of 15 km from the Tombali Region, which is closest to the river estuary (because of budget constraints),
- located in the Boé Sector in the east of the country (because of budget constraints and poor phone signal in the area),
- lacked reliable GPS and population data (i.e., unmatched from the fuzzy merging of the census and the GPS data),
- located in Biombo Region to the west of the capital city, Bissau (used for the pilot).

These exclusions accounted for 40% of producers in the country, mostly driven by exclusion of smaller villages. We posited that, because most of the excluded villages were smaller and more remote, producers living in those excluded villages were likely to be most affected by lack of information and could benefit more from the intervention. Once the final sample of villages was selected, we sought the contact details of the village leaders of our final sample of villages. Whenever possible, we contacted the village leaders ahead of the data-collection baseline visit to inform them of the study and seek their collaboration.

Producer-Level Sampling

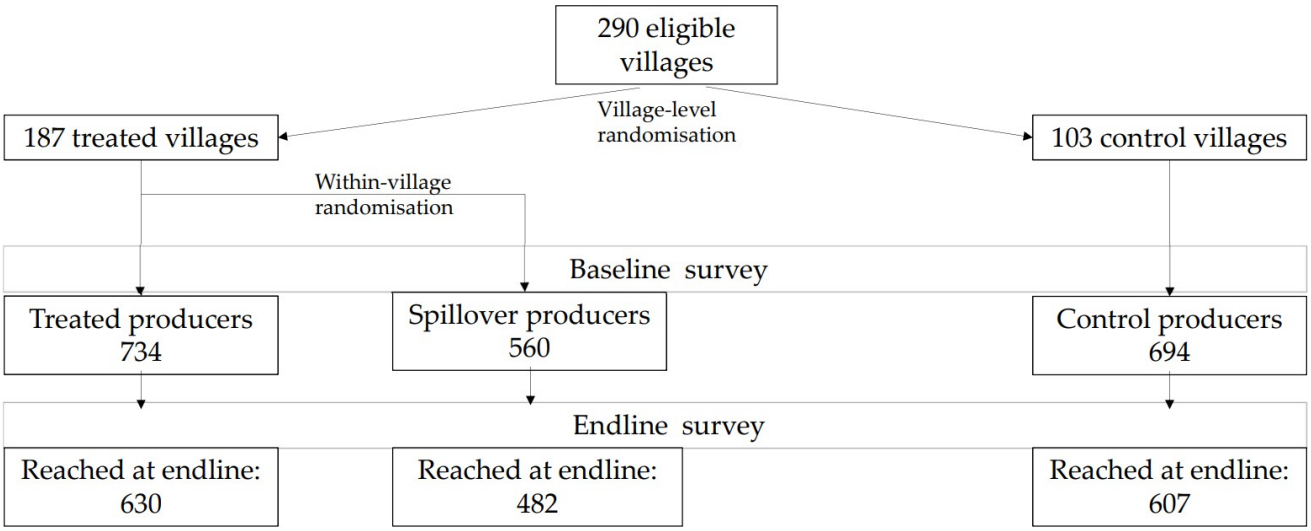
[18] We constructed our sampling frame by merging the 2009 census data, the latest census available to-date, with GPS coordinates obtained from a geocoded administrative dataset maintained by the United Nations Office for the Coordination of Humanitarian Affairs.

After the data-collection team reached the sampled village and the village-leaders granted them permission to work, they asked the village leader for a list of all producers living in the village owning a cashew plantation. In eliciting this list, the data-collection team stressed that every producer with a cashew plantation should be included, including small ones. On the day of the visit, the data-collection team used a random number generator to sample seven producers from this list.

3.3. Randomization

Figure 2 shows how participants in the study were allocated across treatment, spillover and control groups. The rest of this section provides details on how we conducted the randomization to reach this allocation.

Figure 2: Flowchart of Participants through the Study



Village-Level Randomization

We followed the recommendations of Bruhn and McKenzie (2009), stratifying our randomization to increase efficiency. Randomization of treatment across villages was implemented by constructing, in each region, triplets of villages that were as similar as possible along a number of dimensions that were likely to affect the impact of treatment, and that were available to use. We combined population data from the 2009 census and

other geocoded databases to construct the following variables:

i) road distance to the nearest sector capital (to proxy the closest location where small intermediaries are based)
ii) road distance to the nearest regional capital (to proxy the closest location where wholesale intermediaries are based)
iii) road distance to the port in Bissau (to proxy for distance from the main export route, and inversely from distance to the closest borders)
iv) linear distance to the nearest (MTN) mobile network tower, and
v) number of households for each village, according to the 2009 census.

Because these characteristics are likely to be correlated, we used the Mahalanobis distance as a metric of similarity across villages that takes into account of the correlation across these characteristics. The Mahalanobis distance between them is then defined as:

$$||z_l - z_j|| = ((z_l - z_j)'S{-}1(z_l - z_j))1/2(1)$$

where z_l and z_j denote the vector or relevant characteristics from villages *l* and *j*, respectively, and *S* is the covariance matrix of characteristics *z*. Pairs of villages with a smaller Mahalanobis distance are more similar along these dimensions. Since these characteristics are weighted by the inverse of the covariance matrix *S*, correlation between characteristics e.g. between our various distance measures is given less weight.

Within each region we assigned villages into triplets that minimized the sum, over all triplets, of the Mahalanobis distances within each triplet. The search was conducted using an algorithm that randomly tried different assignments of villages into triplets. Within each triplet, one village was then randomly assigned to control and two villages to treatment.

Within-Village Randomization

Once the seven randomly sampled producers in treatment villages completed the baseline interview, an on-the-spot, within-village lottery determined producer-level assignment to either the treatment or spillover groups and overseen by the supervisor of data collection. Using this lottery, four producers were assigned to the treatment group and three to the spillover. After producer-level randomization, the treated producers

took part in a training session about the intervention and the determinants of farmgate raw cashew nut prices.

3.4. Endline Survey

Our analysis of the effects of the intervention is based on outcomes collected during an in-person survey with producers in every village in our study, between April and May 2021. During this survey we interviewed 86% of producers who had taken part in the baseline in 2019. We also recovered a transaction diary that we had left with producers during the baseline survey for them to fill with details of each cashew-nut transaction during the 2020 trading season.

Finally, after completing the survey, producers in both the treatment and control villages were provided with information on the service and were shown how to subscribe as fee-paying users to receive information during the remainder of the 2021 trading season.

3.5. Experimental Integrity

Appendix A.1 presents the baseline balance, compliance, and attrition from the endline survey.

Appendix Tables 12 and 13 show that our baseline sample is relatively balanced across treatment arms for our outcome variables of interest. The differences between the mean of seven of the twenty-seven outcome variables were statistically significant across groups, but these differences were small: none of the pairwise standardized differences in means was larger than 0.25 standard deviations. Also, only two of these differences were are statistically significant at the 5% level. Moreover, our empirical strategy included the baseline value of the outcomes as a control variable.

Appendix Tables 14 and 15 show that our baseline sample was relatively balanced

across treatment arms across producer-level and village-level baseline characteristics. The differences between the mean of eight of the twenty-seven producer-level characteristics were statistically significant across groups, but these differences were small: none of the pairwise standardized differences in means was larger than 0.25 standard deviations.

Attrition in the endline survey was 14% overall and it was not correlated with treatment assignment, as shown in Appendix Table 16.

3.6. Empirical Strategy

We estimated models of the form:

$$y_{iv} = treatment_{iv} \cdot \beta + spillover_{iv} \cdot \delta + y_{0iv} \cdot \gamma + \alpha_v + \varepsilon_{iv} \qquad (2)$$

where:

- i and v refer to individuals and villages, respectively,
- y_{iv} denotes the outcome of interest measured in the follow-up,
- y_{0iv} denotes the outcome of interest measured in the baseline,
- $treatment_{iv}$ denotes individual-level assignment to the treatment group,
- $spillover_{iv}$ denotes individual-level assignment to the spillover group in treated villages,
- $\boldsymbol{\alpha}_v$ denotes the randomization triplet fixed effect (as described in Section 3.3), and
- $\boldsymbol{\varepsilon}_{iv}$ is the unobserved variation in the outcome.

We clustered standard errors at the village-level, the unit of the first randomization.

Our coefficient of interest is **β**, the intent to treat (ITT) effect. To measure take-up

of the intervention, we defined a dummy variable ($takeup_{iv}$) equal to one if the respondent received at least eight messages during the 2020 trading season.[19] By including the baseline value of the outcome as a control, we directly accounted for any baseline imbalances in the outcome of interest. We also estimated treatment-on-the-treated (TOT) effects, by adapting Equation 2 and by replacing $treatment_{iv}$ with $takeup_{iv}$ instrumented by $treatment_{iv}$. We used the latter estimation to obtain estimates of the average effect for the subgroup of compliers that used the service (not all those assigned to treatment received all the weekly messages). We remain cautious in interpreting the magnitude of these effects because they assume that non-compliers had no effects from our treatment.[20]

3.7. Inference and Multiple-Hypothesis Testing Adjustments

For each of our pre-specified outcomes, we tested the following hypotheses:

(i). H_0: $\boldsymbol{\beta} = 0$: The intervention had no effect;
(ii). H_0: $\boldsymbol{\delta} = 0$: The intervention had no spillover effect;
(iii). H_0: $\boldsymbol{\beta} = \boldsymbol{\delta}$: The intervention had no effect relative to the spillover group;

For each of these hypothesis tests, we report the False Discovery Rate (FDR) adjusted q-values taken across the family of outcomes (Benjamini, Krieger & Yekutieli, 2006). For each type of test, we constructed a q-value for that test across outcomes. That is, we constructed a set of q-values using all p-values for the null hypothesis "The intervention had no effect." We constructed a set of q-values using all p-values for the null hypothesis "The intervention had no spillover effect" as well as one for a set of q-values using all p-values for the null hypothesis "The intervention had no effect relative to the spillover group."

For clarity, we link the statistical hypotheses above with underlying economic

[19] We used administrative data collected by MTN to construct this variable. We include both robocalls listened for at least 45 seconds and SMS received to define this measure of take-up.
[20] To interpret this effect as a local average treatment effect (LATE) for the subgroup of compliers, we assumed that there were no defiers (i.e., that assignment to service did not induce people *not* to use it), that we had compliers (as shown in Tables 9 and 17), and that allocation to the service was random and not related to the potential outcomes of respondents.

predictions. A rejection of the null hypothesis (i) implies that the random allocation to receive market information did affect such producer outcomes as prices and revenues. A rejection of the null hypothesis (ii), conversely, implied that the intervention affected the outcomes of untreated producers living *within* treated villages. These spillovers may have been the result of communication between treated producers and untreated producers living within the same village, for example. Rejecting null hypothesis (iii) implied that producers who were allocated to the intervention (and also participated in the training) were differentially affected by the treatment relative to untreated producers in the same village.[21]

IV. Results

In this Section, we present the main effects of the intervention, estimated using the data collected in the endline survey. We first focus on the primary outcomes of interest (prices and revenue), before turning our analysis to quantities of raw cashew nuts devoted to different transactions (sold for cash, exchanged for rice, or used to repay loans). The analysis follows our pre-analysis plan, and we note where we may have deviated from it.

4.1. Prices and Revenue

Our intervention failed to increase the average price for sales among treated producers, but treated producers managed to gain a higher total value from all sales and exchanges relative to the control group. Table 2 shows results from the endline survey on prices and revenue from sales and exchanges. We present estimates of both ITT and TOT effects. In general, the estimates from both models yield similar results, with the magnitude of TOT effects being generally larger than the ITT effects. The estimation

[21] We did not explicitly test whether spillovers may have occurred between villages. This type of spillover is theoretically possible and, if we assumed them to be positive, could introduce a downward bias into our ITT effects. For now, we leave the analysis of this issue for future research.

sample includes all the producers who we reached at endline. In order not to condition our outcome on the decision to sell, we recoded the price per sale to be equal to zero for producers who conducted no sales and added, as a control, an indicator equal to one for observations for which we imputed this zero price. Our results were not affected by this imputation strategy once we controlled for it in the regression model.

Our first finding is that the intervention did not increase the average price of sales among treated producers. The first row shows that producers in the treatment group reported sale prices that were, on average, 2 XOF higher than those of the control group (Column 2), but this difference represents less than 1% of the control mean and was not statistically significant. We found no difference between the treatment group and the spillover group in the average prices. The TOT results (Columns 5-7) support the same conclusion as the ITT results.

Table 2: Results – Prices and Revenue

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
Price per sale per kg	295.19	2.02	2.30	-0.28	3.81	2.31	1.50
	(105.01)	(3.46)	(3.35)	(3.30)	(6.53)	(3.37)	(5.53)
	1588	[0.56]	[0.49]	[0.93]	[0.56]	[0.49]	[0.94]
Value of all sales and exchanges	287785.22	61176.24**	45506.70*	15669.55	115109.37**	45738.14*	69371.23*
	(315352.77)	(25342.65)	(26614.95)	(22519.86)	(48250.25)	(26757.26)	(37751.45)
	1521	[0.05]**	[0.18]	[0.65]	[0.05]*	[0.18]	[0.13]
Value of all sales	233494.84	51335.03**	24128.93	27206.10	96854.15**	24329.11	72525.05**
	(292721.24)	(22677.17)	(23273.58)	(19950.57)	(43256.03)	(23412.56)	(34047.52)
	1591	[0.05]**	[0.40]	[0.55]	[0.05]*	[0.40]	[0.13]
Value of exchanges	52325.81	10272.90	18450.93*	-8178.03	19239.11	18425.78*	813.32
	(88037.41)	(8155.30)	(9779.94)	(7461.48)	(15348.07)	(9769.10)	(11444.38)
	1636	[0.28]	[0.18]	[0.55]	[0.28]	[0.18]	[0.94]

Notes: intention-to-treat (ITT) estimates reported in columns 2 and 3 and treatment-on-the-treated (TOT) estimates reported in columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 test for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for the randomisation triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Stars on the coefficient estimates reflect unadjusted *p*-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. * denotes significance at 10 pct.; ** at 5 pct.; and *** at 1 pct. level. Column 1 displays the control mean; standard deviation; and total number of observations across all groups.

To better understand the failure of our intervention to increase average producer prices, we plot the distribution of prices across treatment arms in Figure 3. Two patterns emerge from the distribution of prices. The y-axis plots the count of producers we interviewed during the 2021 follow-up, First, control producers appear to report more frequently the median price of 300 XOF/kg relative to both treatment and spillover group. Second, differences in outcomes are likely to be the result of changes on the

intensive margin (through additional sales), rather than the extensive margin (making any sale at all). There are no differences across groups in the likelihood of report no sales at all, as shown by the left-most bars in the Figure.[22]

Despite the failure of the intervention to increase average prices, the second row in Table 2 shows that the total value of cashews that were either sold or exchanged (directly for rice) is 61,176 XOF (q-value: 0.05), higher among producers in the treated group (ITT) relative to the control mean. This increase in the value of cashews sold or exchanged corresponds to 21% of the control group mean.[23] The treatment-on-the-treated estimates, reported in Column (5), show that the increase in the value of cashews sold or exchanged was substantially higher—115,109 XOF (q-value: 0.05)—which corresponds to 40% of the control group mean. Relative to the spillover group, producers in the treatment group earned a marginally higher revenue, on average, but this difference was not statistically different from zero in our ITT estimates. Regarding TOT estimates (Column 7), the difference was marginally significant at the 10% level using a naive p-value, although the q-value was higher than 0.1. We note that these estimates are noisy, judging from the standard errors of our coefficients, though a similar qualitative pattern remains when we winsorized total revenue at the 99th percentile (results not shown, but available upon request).

In the bottom rows of Table 2, we show the effects of the intervention on the value of monetary sales and the value of cashews exchanged for rice. The results show that an increase in the value of monetary sales accounts for the treatment effects on the sum of these two components. Treated producers obtained on average 51,335 XOF (q-value: 0.05) more earnings from sales of cashew nuts relative to the control group, a 22% increase relative to the control group mean. This difference in TOT estimates was even larger (96,854 XOF, q-value 0.05), which corresponded to 41% of the control group

[22] To make the outcome unconditional, we recoded the average price to be equal to zero for producers that did not report any monetary sales.

[23] While the average price of sales is only computed for monetary transactions, the total value of all sales and exchanges includes also the total revenue from cashew trades that were repaid in rice. We value the rice received in exchange of cashews using elicited hypothetical valuations from producers. We obtained these valuations through a specific module in our questionnaire designed to ask how much producers think the rice individuals in their village receive in exchange for cashews is worth in monetary terms.

mean. Similarly to the aggregate, the difference between the treatment and spillover groups was larger in the TOT estimates relative to the ITT estimates, but this difference was not statistically significant once we accounted for multiple-hypothesis testing. We found that producers in the spillover group reported higher value of cashews exchanged for rice relative to the control group (18,450 XOF, q-value: 0.18), though this effect was not statistically significant once we accounted for multiple-hypothesis testing. We found no significant differences between the treatment and the spillover group. These results might be interpreted as tentative evidence of potential spillover effects of our intervention.

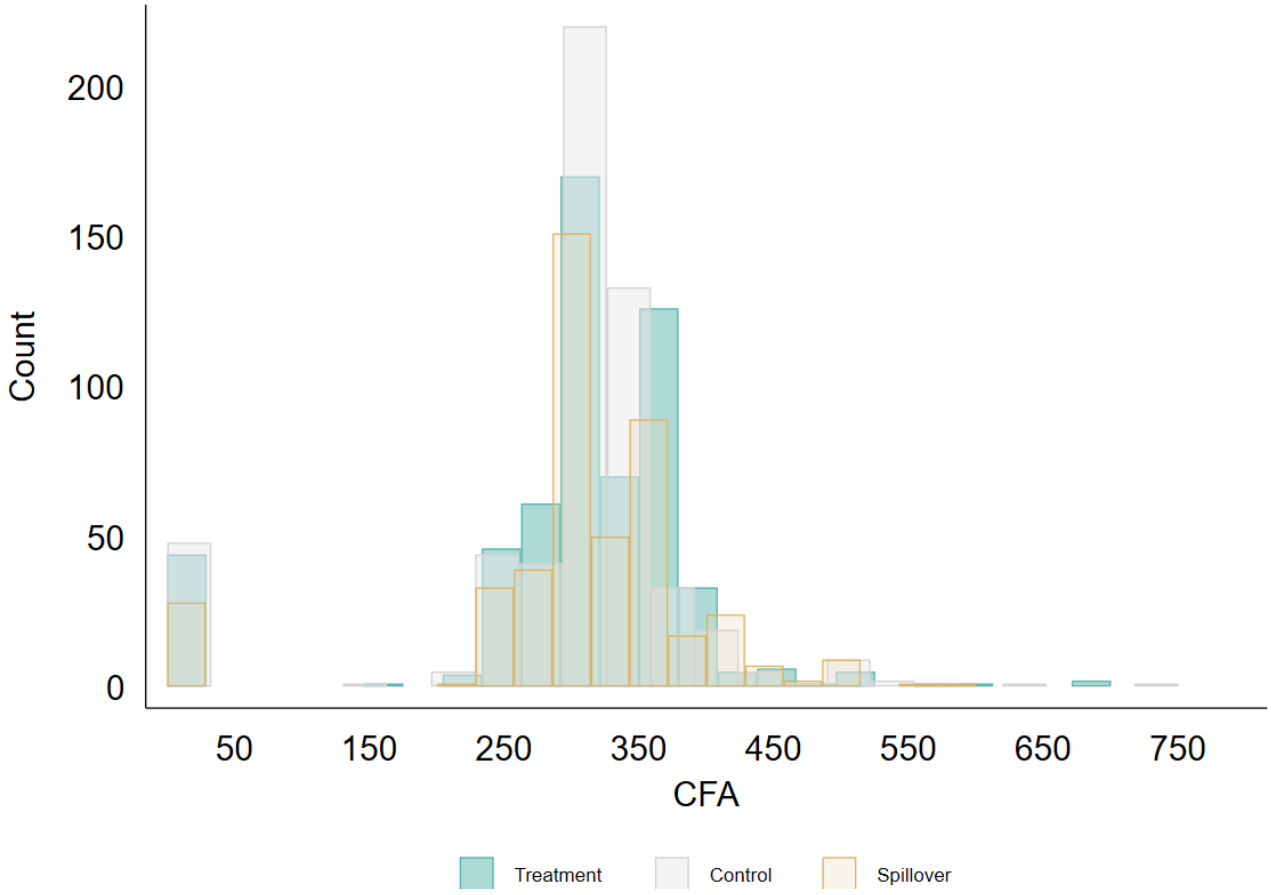
4.2. Quantity Sold or Exchanged for Rice or Loans

We next analyzed producers' quantities of cashews sold, exchanged, or used in interlinked credit transactions. Changes in the amounts of cashews sold or exchanged can help explain the effects of the intervention on revenue, given that we found no significant effect on average prices. Indeed, Table 3 shows that the treatment group sold, on average, 142 kgs (q-value: 0.05) more than those in the control group, a 20% increase relative to the control group mean based on our ITT estimates. Our TOT estimates show an increase of 266 kg (q-value: 0.06), corresponding to 37.5% of the control mean. The difference between the spillover and treated producers was not statistically significant based on our ITT estimates, but our TOT estimates showed a statistically significant difference in the quantity sold between treated and spillover producers of 202 kg of cashews (q-value: 0.08). We found no significant differences between the control and spillover producers in the amount of cashews sold.

Our intervention induced producers to sell more frequently their cashews relative to the control and spillover groups. Treated producers sell their cashew more times during the season, with average sales that were 0.21 higher (q-value: 0.00) relative to the control group. As shown in Column 5, our TOT estimates were larger and point to an average increase of 0.39 sales, or 26% of the control mean. This behavior was consistent with the advice provided by our intervention, which advised producers to sell cashews in

multiple sales, given an expected increase in prices in the latter half of the trading season. We found no increase in the number of sales among producers in the spillover group.

Figure 3: Distribution of Sale Prices by Treatment Arm



Source: Endline survey. Prices are reported in nominal West African CFA francs (XOF). We recoded the price per sale to be equal to zero for producers who did not conduct any sales. Count refers to the number of producers in the sample.

Table 3: Results – Cashew Sales, Exchanges, and Loans

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
Total quantity sold	708.21	141.75**	63.53	78.21	265.80**	63.28	202.52**
	(855.14)	(61.11)	(62.11)	(54.72)	(116.02)	(62.31)	(93.02)
	1622	[0.05]*	[0.43]	[0.38]	[0.06]*	[0.43]	[0.08]*
Number of sales	1.49	0.21***	0.07	0.14**	0.39***	0.07	0.32***
	(1.01)	(0.06)	(0.06)	(0.06)	(0.11)	(0.06)	(0.10)
	1693	[0.00]***	[0.43]	[0.10]*	[0.00]***	[0.43]	[0.00]***
1 if exchanged cashews for rice	0.56	-0.01	-0.03	0.03	-0.01	-0.03	0.02
	(0.50)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.05)
	1706	[0.85]	[0.43]	[0.59]	[0.85]	[0.43]	[0.83]
Total quantity exchanged	217.70	16.80	28.14	-11.34	31.57	28.12	3.45
	(323.48)	(24.59)	(26.50)	(24.87)	(46.25)	(26.47)	(39.29)
	1681	[0.62]	[0.43]	[0.81]	[0.62]	[0.43]	[0.93]
Share of quantity sold over quantity exchanged and sold	0.73	0.02	0.02	0.00	0.04	0.02	0.02
	(0.32)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.03)
	1604	[0.62]	[0.48]	[0.87]	[0.62]	[0.48]	[0.83]
Loans:							
1 if borrowed money or rice	0.31	0.02	0.03	-0.01	0.04	0.03	0.01
	(0.46)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1702	[0.68]	[0.57]	[0.75]	[0.68]	[0.57]	[0.84]
Implicit value of loans per kg of cashews	62.57	32.93*	3.48	29.45	62.17*	3.70	58.47*
	(146.32)	(17.61)	(11.38)	(18.08)	(33.17)	(11.37)	(31.78)
	1423	[0.25]	[0.76]	[0.42]	[0.25]	[0.74]	[0.27]
Total quantity paid for loans	44.09	-2.96	6.76	-9.73	-5.55	6.77	-12.32
	(106.88)	(7.16)	(9.02)	(8.18)	(13.40)	(9.00)	(11.74)
	1686	[0.68]	[0.61]	[0.43]	[0.68]	[0.60]	[0.59]
Share of quantity sold over quantity exchanged and paid in loans	0.86	0.01	0.03	-0.02	0.02	0.03	-0.01
	(0.29)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
	1599	[0.68]	[0.47]	[0.43]	[0.68]	[0.47]	[0.84]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups.

Treated producers did not exchange a higher quantity of cashews for rice relative to control producers, and the same was true for producers in the spillover group. The total quantity of cashew exchanged for rice was larger for both treated and spillover producers, more so for the latter, but the difference relative to the control group was not statistically significant. We found no treatment or spillover effects of the intervention on the share of the quantity sold over the quantity exchanged and sold, but we noted that treated producers were not more likely to borrow money or rice through cashew-nut repayments. The average quantity of cashews paid for loans was not different across different groups, and we also found no differences in the share of quantity sold over the quantity exchanged and paid in loans. We found that treated producers earned a marginally higher implicit value of the loans repaid through cashew nuts relative to

control producers. We were cautious in interpreting this outcome, because it was observed in only around 30% of our sample and was recoded to zero for producers who did not engage in any loans.[24] On average, treated producers obtained an extra 33 XOF/kg of cashews used as repayment of loans, a 53% increase relative to the control group, based on our ITT estimates. Our effects on the implicit value of cashews used to repay loans were statistically significant only at the 10% level based on p-values but were not significant once we accounted for multiple-hypothesis testing across outcomes in the same family.

V. Mechanisms

Following our pre-analysis plan, we examined a number of different potential mechanisms. First, we looked at the timing of transactions by producers. We also explored whether the treatment changed producers' knowledge about the cashew market or increased producers' bargaining power. Third, we checked whether the increase in revenue was the result of a change in the amount of cashews produced. Finally, we tried to rule out whether our results could be explained by changes in outcomes where we would a priori not expect to see any results—that is, a set of placebo outcomes.

5.1. Marketing Behavior and Timing of Sales

As Table 4 shows, treated producers reported selling relatively more and exchanging fewer cashews for rice during the start of the trading season (in or before

[24] In our regression, as an additional control, we added an indicator equal to one for producers whose implicit value of loans we recoded to be equal to zero.

April 2020) relative to the control group. This period coincided with the time when we started sending messages to treated producers, though the messages advised producers to wait to sell for prices that at least matched the reference price.[25] Treated producers were three percentage points more likely to report exchanging cashew nuts for rice towards the end of the trading season (July 2020 or later), though this outcome was extremely low among the control group (only 1% of the control group reported exchanging cashews for rice in this period).

Table 4: Results - Timing

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
1 if sold cashews in April 2020 or before	0.15	0.04**	0.02	0.02	0.08*	0.02	0.06
	(0.35)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)	(0.04)
	1361	[0.17]	[0.80]	[0.99]	[0.17]	[0.79]	[0.75]
1 if sold cashews in May 2020	0.51	0.02	-0.01	0.03	0.05	-0.01	0.05
	(0.50)	(0.03)	(0.04)	(0.03)	(0.06)	(0.04)	(0.05)
	1361	[0.71]	[0.88]	[0.99]	[0.71]	[0.90]	[0.75]
1 if sold cashews in June 2020	0.49	0.05	0.05	-0.00	0.09	0.05	0.04
	(0.50)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.05)
	1361	[0.29]	[0.33]	[0.99]	[0.29]	[0.32]	[0.75]
1 if sold cashews in July 2020 or later	0.07	0.01	0.01	0.00	0.02	0.01	0.01
	(0.25)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
	1361	[0.71]	[0.81]	[0.99]	[0.71]	[0.80]	[0.93]
1 if exchanged rice in April 2020 or before	0.09	-0.03*	-0.03*	0.00	-0.05*	-0.03*	-0.02
	(0.28)	(0.01)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
	1591	[0.17]	[0.21]	[0.99]	[0.17]	[0.21]	[0.75]
1 if exchanged rice in May 2020	0.23	-0.01	-0.00	-0.00	-0.01	-0.00	-0.01
	(0.42)	(0.02)	(0.03)	(0.02)	(0.05)	(0.03)	(0.04)
	1591	[0.81]	[0.90]	[0.99]	[0.81]	[0.90]	[0.93]
1 if exchanged rice in June 2020	0.26	-0.01	-0.02	0.01	-0.03	-0.02	-0.00
	(0.44)	(0.03)	(0.03)	(0.02)	(0.06)	(0.03)	(0.04)
	1591	[0.76]	[0.80]	[0.99]	[0.76]	[0.80]	[0.93]
1 if exchanged rice in July 2020 or later	0.01	0.03***	0.03***	0.00	0.05***	0.03***	0.02
	(0.11)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
	1591	[0.01]**	[0.05]*	[0.99]	[0.01]**	[0.05]*	[0.75]
Not pre-specified:							
Quantity of cashews sold in May 2020 or before	324.45	93.90**	2.21	91.69*	174.70**	3.59	171.11**
	(597.20)	(44.06)	(44.02)	(46.78)	(82.94)	(44.47)	(74.50)
	1288	[0.07]*	[0.96]	[0.10]	[0.07]*	[0.94]	[0.04]**
Quantity of cashews sold in June 2020 or later	398.16	66.95	58.71	8.23	124.48	59.64	64.83
	(713.40)	(56.60)	(59.16)	(56.04)	(105.86)	(59.71)	(88.89)
	1288	[0.24]	[0.64]	[0.88]	[0.24]	[0.64]	[0.47]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups.

The difference in timing of sales is consistent with treated producers selling more than once during the trading season. The bottom panel of Table 4 shows that, prior to

[25] Appendix Table 20 shows the content of the messages sent in 2020.

the official start of the 2020 trading season, treated producers were selling a larger amount of cashews earlier relative to both control and spillover producers. From comparing the control group mean of the quantity sold in May 2020 or before (325 kg) relative to the quantity sold May 2019 or before (398 kg), we can see that earlier sales were, on average, smaller relative to later ones. Thus, treated producers who had been informed about the prospect of prices rising in the future by the intervention started selling a share of their total production earlier relative to other producers.

Table 5: Results- Reasons for Choosing How Many Times to Sell

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
Not pre-specified:							
1 if sold more than once: to get better prices when selling more than once	0.23	0.07***	0.02	0.04	0.12***	0.02	0.10**
	(0.42)	(0.02)	(0.02)	(0.03)	(0.04)	(0.02)	(0.04)
	1693	[0.01]**	[0.71]	[0.16]	[0.01]**	[0.72]	[0.03]**
1 if sold more than once: because it was advised by N'kalô	0.01	0.03***	-0.00	0.03***	0.05***	-0.00	0.05***
	(0.09)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	1693	[0.00]***	[0.93]	[0.02]**	[0.00]***	[0.94]	[0.01]***
1 if sold more than once: to smooth consumption	0.22	0.05**	-0.01	0.06**	0.09**	-0.01	0.10**
	(0.41)	(0.02)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1693	[0.07]*	[0.93]	[0.07]*	[0.07]*	[0.94]	[0.03]**
1 if sold once: to get better prices when selling only once	0.23	-0.03	0.03	-0.06*	-0.05	0.03	-0.08*
	(0.42)	(0.02)	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)
	1693	[0.22]	[0.71]	[0.11]	[0.22]	[0.72]	[0.07]*
1 if sold once: because it was advised by N'kalô	0.01	0.01	0.00	0.01	0.02	0.00	0.02*
	(0.12)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	1693	[0.17]	[0.93]	[0.19]	[0.17]	[0.94]	[0.10]*
1 if sold once: to pay for urgent expenses	0.27	-0.07**	-0.03	-0.04	-0.12**	-0.03	-0.09**
	(0.45)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1693	[0.03]**	[0.71]	[0.16]	[0.04]**	[0.72]	[0.03]**

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups.

To understand what motivated producers to sell more than once, we used an open-ended question to elicit their reasons for adopting this sale strategy. In the first three rows of Table 5, we report producers' responses by treatment status. Treated producers were three percentage points more likely to directly refer to the market information system as a reason for selling more than once. Treated producers were also seven percentage points more likely to say they sold more than once because they thought that prices would increase in the future and because they thought this strategy would reduce their risk of price uncertainty. This reasoning is consistent with the information delivered by the market information system, which suggested that prices would increase. Moreover, we see that treated producers are also more likely to sell more than once because they report that this enabled them to smooth consumption (i.e. to

avoid spending all the revenue at once or because they lacked liquidity).

We asked producers both whether they had delayed or sped up sales because of expected price changes and to whom they had sold most of their cashew nuts. We also checked whether producers were more likely to report selling their cashews to a buyer in neighboring Senegal. After accounting for multiple-hypothesis testing, we found no evidence of any change in any of these decisions as a result of our intervention (see Table 6). We highlight the high proportion of our sample that reported delaying sales in the expectation that prices would increase—almost 80% among control group producers.[26]

Table 6: Results – Marketing Behavior

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
1 if delayed sales because expected price to rise	0.79	-0.01	-0.01	0.00	-0.02	-0.01	-0.01
	(0.41)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)
	1703	[0.73]	[0.82]	[0.96]	[0.73]	[0.82]	[0.86]
1 if sped up sales because expected price to drop	0.27	0.04	0.03	0.00	0.07	0.03	0.03
	(0.44)	(0.02)	(0.02)	(0.03)	(0.05)	(0.02)	(0.04)
	1694	[0.34]	[0.47]	[0.96]	[0.34]	[0.47]	[0.69]
1 if sold most to local buyer	0.43	-0.02	0.04	-0.06*	-0.04	0.04	-0.07
	(0.50)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.05)
	1622	[0.73]	[0.47]	[0.45]	[0.73]	[0.47]	[0.30]
1 if sold most to itinerant buyer	0.43	0.04	0.01	0.04	0.08	0.01	0.07
	(0.50)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.05)
	1622	[0.34]	[0.82]	[0.77]	[0.34]	[0.82]	[0.30]
1 if sold most directly to a market	0.04	-0.02**	-0.02	-0.01	-0.05**	-0.02	-0.03*
	(0.20)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
	1622	[0.16]	[0.47]	[0.80]	[0.17]	[0.47]	[0.30]
1 if sold in or close to Senegal	0.01	0.00	-0.00	0.00	0.00	-0.00	0.01
	(0.11)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	1693	[0.73]	[0.82]	[0.86]	[0.73]	[0.82]	[0.74]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups..

5.2. Bargaining and Information Updating

We next explored whether the information received by treated producers increased their bargaining power during sales negotiations. As shown in Table 7, the service did

[26] In 2020, this strategy could have been profitable for producers as prices increased in the latter half of the trading season, when international trade increased after the initial tightening caused by the COVID-19 pandemic.

not make treated producers more likely to successfully bargain for a higher price. We found no evidence that the treatment induced producers to act as intermediary buyers. In our control group, 7% of producers reported having bought cashews from other producers for resale. Interestingly, however, we found that producers in the spillover group reported receiving offers from more buyers relative to the control group. The difference between the treatment and spillover group is negative but not statistically significant after accounting for multiple-hypothesis testing. A possible explanation for the latter pattern is that the service may have induced some traders to try to purchase cashew nuts from other producers in the same village who were less well informed about market developments as were treated producers. On average the control group reported receiving offers from about three potential buyers. The spillover producers received offers from an extra 0.3 buyers (q-value: 0.01) relative to the control group, an increase of 10% of the control group mean based on our ITT estimates.

Table 7: Results – Bargaining

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
Number of succesful bargains	0.14	-0.00	-0.02	0.01	-0.01	-0.02	0.01
	(0.37)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)
	1690	[0.89]	[0.44]	[0.57]	[0.89]	[0.44]	[0.84]
1 if acted as intermediary	0.07	0.01	0.01	-0.01	0.01	0.01	-0.01
	(0.26)	(0.01)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
	1713	[0.89]	[0.44]	[0.57]	[0.89]	[0.44]	[0.84]
Number of potential buyers that made offers	2.91	0.08	0.30***	-0.21**	0.16	0.30***	-0.14
	(1.82)	(0.09)	(0.10)	(0.10)	(0.17)	(0.10)	(0.16)
	1671	[0.89]	[0.01]***	[0.12]	[0.89]	[0.01]***	[0.84]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups.

We found no evidence that treated producers reported a higher willingness-to-pay for the service after having had access during the 2020 trading season, relative to control or spillover groups.[27] We do not interpret a lack of treatment effects on the willingness-to-

[27] This finding contrasts with the report of Cole and Fernando (2021), who showed that access to mobile agricultural services in India increased the willingness-to-pay for these services among users. Context and type of intervention both varied between these studies, so a direct comparison is only illustrative.

pay for the service as a lack of appreciation for the service, given that the majority of qualitative feedback we collected from treated producers on the quality of the service was positive.[28] We found only weak evidence that treated producers were better informed about relevant news regarding the cashew market in the following trading season, as shown in Table 8. Treated producers were not more likely to know the official reference price set by the government in the 2021 trading season relative to those in the control group. When asked to report what reference price had been announced, the absolute difference between the reported price and the actual official reference price (360 XOF/kg) was not different across producers across the different experimental groups.[29] Producers' expected sale price for the 2021 trading season was generally high (above 500 XOF/kg in the control group), especially in comparison to the reference price. We found that treated producers had lower expected prices relative to both the spillover and control group, though these differences were not statistically significant. Expecting a lower price in 2021 could be interpreted as having more realistic expectations.

[28] We elicited willingness-to-pay through unincentivized hypothetical questions, which have been shown to perform as well as incentivized elicitation methods in other contexts.

[29] We had asked about knowledge of the reference price for the 2021 trading season, which was announced by the government in the first week of April 2021.

Table 8: Results – Information Updating

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
1 if delayed sales because expected price to rise	0.79	-0.01	-0.01	0.00	-0.02	-0.01	-0.01
	(0.41)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)
	1703	[0.73]	[0.82]	[0.96]	[0.73]	[0.82]	[0.86]
1 if sped up sales because expected price to drop	0.27	0.04	0.03	0.00	0.07	0.03	0.03
	(0.44)	(0.02)	(0.02)	(0.03)	(0.05)	(0.02)	(0.04)
	1694	[0.34]	[0.47]	[0.96]	[0.34]	[0.47]	[0.69]
1 if sold most to local buyer	0.43	-0.02	0.04	-0.06*	-0.04	0.04	-0.07
	(0.50)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.05)
	1622	[0.73]	[0.47]	[0.45]	[0.73]	[0.47]	[0.30]
1 if sold most to itinerant buyer	0.43	0.04	0.01	0.04	0.08	0.01	0.07
	(0.50)	(0.03)	(0.03)	(0.03)	(0.06)	(0.03)	(0.05)
	1622	[0.34]	[0.82]	[0.77]	[0.34]	[0.82]	[0.30]
1 if sold most directly to a market	0.04	-0.02**	-0.02	-0.01	-0.05**	-0.02	-0.03*
	(0.20)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
	1622	[0.16]	[0.47]	[0.80]	[0.17]	[0.47]	[0.30]
1 if sold in or close to Senegal	0.01	0.00	-0.00	0.00	0.00	-0.00	0.01
	(0.11)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
	1693	[0.73]	[0.82]	[0.86]	[0.73]	[0.82]	[0.74]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups..

The bottom panel of Table 8 shows three additional outcomes related to information updating that we had not included in our pre-analysis plan. Consistent with the pattern of expected prices, we found that treated producers' ideal reference price for the trading season was also relatively lower than for other groups, though this difference was never statistically different from zero. We found only weak evidence of information-sharing among producers as a result of the intervention. Treated producers were marginally more likely to share information about prices to others, which could help us explain some of the spillover effects found in the previous Section. Treated producers shared information about offers they had received to 0.77 more producers relative to the control group mean based on our ITT estimates. Our TOT estimates are larger, showing an extra 1.44 producers received information from treated ones. These differences are only statistically significant at the 10% level using naive p-values. However, we also find evidence that producers in our sample were more likely to receive information about prices from other producers. In particular, we found a positive increase of 0.8 more producers sharing information with treated producers. As treated producers are better informed, it is plausible that they could have been the source of advice for other

producers who want to know if the offers they received are profitable.[30]

Table 9: Results – Sources and Content of Advice Received

	Control (1)	ITT (2)	(3)	(4)	TOT (5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
Self-reported engagement with the service:							
1 if heard of mobile Market Information System	0.14	0.30***	0.10***	0.20***	0.56***	0.10***	0.46***
	(0.35)	(0.02)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1714	[0.00]***	[0.00]***	[0.00]***	[0.00]***	[0.00]***	[0.00]***
1 if used mobile Market Information System	0.02	0.25***	0.03	0.22***	0.46***	0.02	0.44***
	(0.16)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)
	1714	[0.00]***	[0.10]	[0.00]***	[0.00]***	[0.12]	[0.00]***
Source of advice:							
1 if received market advice from family and friends	0.49	0.02	-0.02	0.04	0.04	-0.02	0.05
	(0.50)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1713	[0.46]	[0.57]	[0.20]	[0.46]	[0.57]	[0.23]
1 if received market advice from intermediaries	0.17	-0.06***	-0.02	-0.04**	-0.11***	-0.02	-0.09***
	(0.37)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)
	1713	[0.00]***	[0.57]	[0.05]**	[0.00]***	[0.57]	[0.00]***
1 if received market advice from mobile messages	0.04	0.15***	0.01	0.14***	0.28***	0.01	0.27***
	(0.19)	(0.02)	(0.01)	(0.02)	(0.03)	(0.01)	(0.03)
	1713	[0.00]***	[0.57]	[0.00]***	[0.00]***	[0.57]	[0.00]***
1 if received market advice from other sources	0.12	-0.04***	-0.02	-0.02	-0.08***	-0.02	-0.06**
	(0.33)	(0.02)	(0.02)	(0.01)	(0.03)	(0.02)	(0.02)
	1713	[0.01]***	[0.57]	[0.20]	[0.01]***	[0.57]	[0.02]**
Content of advice:							
1 if received advice on best time to sell	0.48	0.05	-0.04	0.08***	0.08	-0.04	0.12***
	(0.50)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.05)
	1700	[0.31]	[0.28]	[0.01]**	[0.31]	[0.28]	[0.02]**
1 if received advice on price to sell at	0.61	0.01	-0.05	0.06**	0.02	-0.05	0.06
	(0.49)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1706	[0.76]	[0.28]	[0.06]*	[0.76]	[0.28]	[0.13]
1 if received advice on who to sell to	0.24	0.03	-0.01	0.04	0.05	-0.01	0.06
	(0.42)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)
	1632	[0.42]	[0.67]	[0.11]	[0.42]	[0.66]	[0.13]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups.

Finally, the source of market information changed among treated producers despite the absence of significant differences in their beliefs and knowledge about the reference price. Table 9 shows that that treated producers self-reported engaging with the service. Both treated and spillover producers were more likely to have heard about the service at follow-up, with treated producers having a higher likelihood of both knowing about the service and using it relative to both spillover and control groups. Interestingly, treated producers reported being less likely to rely on intermediaries and

[30] In Appendix Table 19, we further decompose the number of producers with whom price offers were discussed or shared and found that most of the discussion of offers occurred among producers from the same village. We cannot completely rule out the existence of communication between villages, however, though it is less frequent.

other sources of information, but they were fifteen percentage points more likely to rely on the messages they received on their phones as part of the intervention. Consistent with the findings on the change in timing and frequency of sales, treated producers reported that the service informed their decisions, in particular the timing of their sales (and significantly so, when comparing treated and spillover producers).

5.3. Total Quantity Produced and Alternative Uses of Cashew Nuts

Table 10: Results – Total Quality Produced and Other Uses

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
Total quantity produced	1079.84	183.81**	55.67	128.14	356.13**	56.90	299.23**
	(1000.47)	(93.31)	(90.53)	(82.51)	(180.44)	(90.59)	(145.55)
	1267	[0.25]	[0.67]	[0.55]	[0.25]	[0.66]	[0.20]
1 if lost cashews post-harvest	0.05	0.00	0.02	-0.02	0.00	0.02	-0.01
	(0.22)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
	1708	[0.91]	[0.67]	[0.55]	[0.91]	[0.66]	[0.70]
Quantity lost post-harvest	0.74	-0.03	0.23	-0.26	-0.06	0.23	-0.29
	(5.05)	(0.27)	(0.37)	(0.36)	(0.51)	(0.37)	(0.50)
	1692	[0.91]	[0.67]	[0.59]	[0.91]	[0.66]	[0.70]
1 if processed cashew nuts	0.00	0.00	0.00	-0.00	0.01	0.00	0.00
	(0.04)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)
	1699	[0.70]	[0.67]	[0.91]	[0.70]	[0.66]	[0.76]
Quantity of processed raw cashews	0.15	0.59	0.08	0.52	1.11	0.08	1.03
	(3.68)	(0.52)	(0.34)	(0.53)	(0.97)	(0.34)	(0.93)
	1699	[0.63]	[0.82]	[0.55]	[0.64]	[0.82]	[0.67]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups.

We used responses from the module on different uses of raw cashew nuts to understand what may have caused the increase in the amount of cashews sold. Table 10 shows that treated producers reported 184 more kilograms of cashew nuts across all possible uses, a 17% increase relative to the control group mean based on our ITT estimates. Our TOT estimates are larger than our ITT estimates.[31] However, while these

[31] We defined total quantity produced as the sum of the cashews sold, paid to workers for cleaning and harvesting, exchanged for rice (including those used in small regular exchanges of less than 25 kg per week),

differences are statistically significant at the 5% level when using naive p-values, we could not reject our null hypothesis of no differences in quantity produced after we accounted for multiple-hypothesis testing. We found no increase of similar magnitude in the total quantity produced among producers in the spillover group. We found no evidence that the treatment affected the quantity or propensity of producers to lose cashew nuts post-harvest as a result of spoilage. We also found no evidence of local processing among producers in our sample, though we note that this outcome is extremely rare in our sample as fewer than ten producers reported any local processing of raw cashews.

5.4. Placebo Outcomes

Finally, we investigated whether our results might have been driven by behavioral outcomes that a priori we would have not expected to change. We first investigated whether treated producers were more likely to report sales because of better record-keeping. After the baseline, all producers had been given a sales diary by the survey team in which to record their sales during the 2020 trading season. In the first row of Table 8, we found no evidence that treated producers were more likely to have used these sales diary relative to spillover or control group producers.[32]

processed into cashews locally, used to repay loans, and used for other purposes, such as seeds for future plantations. In Appendix Table 18, we report our estimates of the additional components of total quantity produced not analyzed in the previous section.

[32] During the in-person interview, the survey team collected the diaries that had been left after the baseline. After data-collection, two operators digitized the data from the sales diaries to check whether they had been correctly used to record the date, quantity, and price of sales during the 2020 seasons. To encourage the use of the sales diary, the survey team promised that producers who kept records could participate in a lottery to win a 50 kg bag of rice. Two placebo messages sent to all producers in 2020 reminded producers to use the sales diary.

Table 11: Results – Placebo Outcomes

	Control (1)	ITT (2)	(3)	(4)	TOT (5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
1 if completed the sale diary well	0.31	-0.03	-0.04	0.01	-0.05	-0.04	-0.01
	(0.46)	(0.03)	(0.03)	(0.02)	(0.06)	(0.03)	(0.04)
	1719	[0.54]	[0.51]	[0.53]	[0.54]	[0.51]	[0.82]
1 if is extremely risk averse	0.35	-0.00	0.03	-0.03	-0.01	0.03	-0.03
	(0.48)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.05)
	1627	[0.89]	[0.51]	[0.51]	[0.89]	[0.51]	[0.74]
1 if trusts most people	0.38	0.06**	0.01	0.04	0.11**	0.01	0.09**
	(0.49)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1712	[0.12]	[0.65]	[0.34]	[0.12]	[0.65]	[0.11]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number control mean, standard deviation, and total number of observations across all groups.

We found no evidence that treated producers responded to an hypothetical lottery in a way that would be extremely risk averse.[33] We found a marginally higher proportion of treated producers reporting that they trust most people in Guinea-Bissau relative to producers in the other two experimental groups. However, this difference was not statistically significant after accounting for multiple-hypothesis testing. We interpret this difference as a weak evidence of an unintended consequence of having taken part in the experiment, though we are not confident in this finding given the lack of statistically significance after correcting for multiple inference.

VI. Conclusion

This paper estimates the effects of introducing a new market information system among cashew producers in Guinea-Bissau. The market information system provided weekly text and voice-messages during the 2020 trading season to treated producers.

[33] We measured extreme risk aversion by asking producers to pick their preferred hypothetical lottery from six alternatives with varying expected means and variances but with a constant standardized mean in the style of Binswanger (1980).

The information sent to producers contained up-to-date farmgate prices, market news, and marketing advice on when to sell. Treated producers changed the frequency and timing of their sales. We found that treated producers sold cashews more frequently in monetary transactions, liquidating their stock across multiple transactions rather than in a single one. By doing so, treated producers earned a larger total revenue relative to untreated ones. We were able to rule out several potential mechanisms that could explain our results. We found no evidence showing that producers changed where or to whom they sold their cashew nuts. In our context and at the time of our intervention, which coincided with 2020 COVID-19 pandemic, it may have been challenging for better-informed producers to sell their stocks elsewhere. We found no evidence to suggest that treated producers had more bargaining power or had a different information set regarding the following trading season. We were also able to rule out the possibility that our effects were the result of better record-keeping induced by our intervention.

Our findings yielded several policy implications. First, we found that the increased revenue among treated producers was substantial in magnitude. Providing up-to-date and reliable information on market conditions seemed to improve the market outcomes of producers in this context. The subscriber fee that users would be charged to use the service could be quickly repaid by the additional returns we observed among treated producers. Second, the baseline government policy of providing a reference price only at the beginning of the trading season can be improved upon through the communication of more frequent price updates.

Several questions remain unanswered. For example, we need to better understand how the service affects producers once it is available to any user in the country, at a cost, and not just our treated sample of producers. One of the limitations of our study is that it offered the service for free to treated producers. Thus, we were unable to measure take-up of the service had users been required to pay for it. Our measure of take-up was based solely on the probability that randomly selected users would be reached and would listen to or read the messages sent by the service. As a future service is rolled-out and its user-base grows, the effects we estimated may change

as more producers become better informed about the market dynamics. We plan to explore some of these issues in future research.

References

Aggarwal, S., Francis, E., and Robinson, J. (2018). Grain Today, Gain Tomorrow: Evidence from a Storage Experiment with Savings Clubs in Kenya. *Journal of Development Economics*, *134*, 1-15.

Aker, J. C. (2010). Information from Markets Near and Far: Mobile Phones and Agricultural Markets in Niger. *American Economic Journal: Applied Economics, 2*, 46-59.

Aker, J. C. and Mbiti, I. M. (2010). Mobile Phones and Economic Development in Africa. *Journal of Economic Perspectives*, *24*, 207-232.

Aker, J. C., Ghosh, I., and Burrell, J. (2016). The Promise (and Pitfalls) of ICT for Agriculture Initiatives. *Agricultural Economics (United Kingdom)*, *47*, 35-48.

Allen, T. (2014). Information Friction in Trade. *Econometrica*, *82*, 2041-2083.

Anderson, M. L. (2008). Multiple Inference and Gender Differences in the Effects of Early Intervention: A Re-evaluation of the Abecedarian, Perry Preschool, and Early Training Projects. *Journal of the American Statistical Association, 103*, 1481-1495.

Benjamini, Y., Krieger, A. M., and Yekutieli, D. (2006). Adaptive Linear Step-up Procedures That Control the False Discovery Rate. *Biometrika*, *93*, 491-507.

Binswanger, H. P. (1980). Attitudes Toward Risk: Experimental Measurement in Rural India. *American Journal of Agricultural Economics*, *62*, 395-407.

Bruhn, M. and McKenzie, D. (2009). In Pursuit of Balance: Randomization in Practice in Development Field Experiments. *American Economic Journal: Applied Economics, 1*, 200-232.

Burke, M., Bergquist, L. F., and Miguel, E. (2019). Sell Low and Buy High: Arbitrage and Local Price Effects in Kenyan Markets. *Quarterly Journal of Economics*, *134*, 785-842.

Camacho, A. and Conover, E. (2019). The Impact of Receiving SMS Price and Climate Information on Small Scale Farmers in Colombia. *World Development*, *123,* 104596.

Casaburi, L., Glennerster, R., and Suri, T. (2013). Rural Roads and Intermediated Trade: Regression Discontinuity Evidence from Sierra Leone. *SSRN Electronic Journal*. Available at https://ssrn.com/abstract=2161643.

Cole, S. A. and Fernando, A. N. (2021). 'Mobile'izing Agricultural Advice Technology Adoption Diffusion and Sustainability. *The Economic Journal*, *131*, 192-219.

Duflo, E., Glennerster, R., and Kremer, M. (2008). Using Randomization in Development Economics Research: A Toolkit. In T. Schultz and J. Strauss, Eds., *Handbook of Development Economics*, 3895-3962.

Fabregas, R., Kremer, M., and Schilbach, F. (2019). Realizing the Potential of Digital Development: The Case of Agricultural Advice, *Science*, 366, eaay3038.

Fafchamps, M. and Hill, R. V. (2008). Price Transmission and Trader Entry in Domestic Commodity Markets. *Economic Development and Cultural Change*, *56*, 729-766.

Fafchamps, M. and Minten, B. (2012). Impact of SMS-Based Agricultural Information on Indian Farmers. *The World Bank Economic Review*, *26*, 383-414.

Goyal, A. (2010). Information, Direct Access to Farmers, and Rural Market Performance in Central India. *American Economic Journal: Applied Economics*, *2*, 22-45.

Hildebrandt, N., Nyarko, Y., Romagnoli, G., and Soldani, E. (2021). Price Information, Inter-Village Networks, and 'Bargaining Spillovers': Experimental Evidence from Ghana. *SSRN Electronic Journal*. Available at https://ssrn.com/abstract=3694558.

Jensen, R. (2007). The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector. *Quarterly Journal of Economics*, *122*, 879-924.

Kadjo, D., Ricker-Gilbert, J., Abdoulaye, T., Shively, G., and Baco, M. N. (2018). Storage Losses, Liquidity Constraints, and Maize Storage Decisions in Benin. *Agricultural Economics*, *49*, 435-454.

Mitra, S., Mookherjee, D., Torero, M., and Visaria, S. (2018). Asymmetric Information and Middleman Margins: An Experiment with Indian Potato Farmers. *The Review of Economics and Statistics*, *100*, 1-13.

Nakasone, E., Torero, M., and Minten, B. (2014). The Power of Information: The ICT Revolution in Agricultural Development. *Annual Review of Resource Economics*, *6*, 533-550.

Osborne, T. (2004). Market News in Commodity Price Theory: Application to the Ethiopian Grain Market. *Review of Economic Studies*, *71*, 133-164.

Svensson, J. and Yanagizawa, D. (2009). Getting Prices Right: The Impact of the Market Information Service in Uganda. *Journal of the European Economic Association*, *7*, 435-445.

Appendix

A.1 Experimental Integrity

Table 12: Baseline balance – Primary Outcome Variables

	Control (1) Mean (SD)	(2) Treatment	(3) Spillover	(4) Treat. vs. spillover	(5) Max pairwise st. diff. Total obs.
Number of sales	1.62	0.01	0.07	-0.05	0.08
	(0.81)	(0.04)	(0.05)	(0.04)	1988
		[0.74]	[0.15]	[0.24]	
Total quantity sold	1206.35	54.39	36.52	17.87	0.01
	(1855.65)	(96.73)	(94.05)	(66.13)	1984
		[0.57]	[0.70]	[0.79]	
1 if exchanged cashews for rice	0.30	0.04	0.02	0.02	0.15
	(0.46)	(0.03)	(0.03)	(0.02)	1985
		[0.11]	[0.49]	[0.33]	
Total quantity exchanged	113.66	59.35***	24.21	35.14**	0.22
	(247.43)	(19.30)	(17.25)	(16.66)	1982
		[0.00]***	[0.16]	[0.04]**	
Share of quantity sold over quantity exchanged and sold	0.90	-0.02	-0.00	-0.02	0.13
	(0.20)	(0.01)	(0.01)	(0.01)	1979
		[0.12]	[0.72]	[0.12]	
Price per sale per kg	395.89	-3.66	1.35	-5.01	0.05
	(96.24)	(5.51)	(5.60)	(4.75)	1968
		[0.51]	[0.81]	[0.29]	
Value of all sales and exchanges	526244.86	36501.52	25459.26	11042.27	0.03
	(920608.05)	(44305.26)	(43326.81)	(30010.71)	1984
		[0.41]	[0.56]	[0.71]	
Maximum price across all sales	411.25	-3.27	3.59	-6.86	0.07
	(100.67)	(5.75)	(5.83)	(5.20)	1968
		[0.57]	[0.54]	[0.19]	
1 if borrowed money or rice	0.16	0.02	0.03	-0.01	0.03
	(0.37)	(0.02)	(0.02)	(0.02)	1943
		[0.35]	[0.15]	[0.52]	
Total quantity paid for loans	25.60	16.26**	7.22	9.04	0.10
	(109.22)	(7.92)	(5.83)	(8.72)	1981
		[0.04]**	[0.22]	[0.30]	
Share of quantity sold over quantity exchanged and paid in loans	0.96	-0.01*	-0.01	0.00	0.00
	(0.13)	(0.01)	(0.01)	(0.01)	1978
		[0.08]*	[0.11]	[1.00]	
Total quantity sold or exchanged	1321.81	112.13	55.63	56.50	0.05
	(1887.20)	(98.48)	(94.97)	(71.35)	1979
		[0.26]	[0.56]	[0.43]	

Notes: Coefficient of treatment and spillover at baseline (Columns 2-3). Column 3 shows the results of tests for differences in parameters obtained in previous two columns. Column 4 reports the standardized pairwise maximum difference between means across all study groups. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. p-values reported in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number of observations.

Table 13: Baseline balance – Secondary Outcome Variables

	Control (1) Mean (SD) Total obs.	(2) Treatment	(3) Spillover	(4) Treat. vs. spillover	(5) Max pairwise st. diff.
Sold at least once	0.99	0.00	0.00	0.00	0.10
	(0.11)	(0.00)	(0.00)	(0.00)	1988
		[0.41]	[0.69]	[0.74]	
1 if sold cashews in April 2019 or before	0.20	-0.02	-0.00	-0.02	0.06
	(0.40)	(0.02)	(0.02)	(0.02)	1854
		[0.24]	[0.93]	[0.32]	
1 if sold cashews in May 2019	0.50	0.01	0.07**	-0.06**	0.14
	(0.50)	(0.03)	(0.03)	(0.03)	1854
		[0.80]	[0.01]**	[0.02]**	
1 if sold cashews in June 2019	0.55	0.04*	0.01	0.04	0.11
	(0.50)	(0.02)	(0.03)	(0.03)	1854
		[0.08]*	[0.81]	[0.20]	
1 if sold cashews in July 2019 or later	0.19	-0.01	-0.00	-0.00	0.06
	(0.39)	(0.02)	(0.02)	(0.02)	1854
		[0.78]	[0.87]	[0.94]	
Value of all sales	486696.38	14815.85	15806.13	-990.28	0.01
	(912168.16)	(43992.64)	(43245.56)	(28614.91)	1984
		[0.74]	[0.72]	[0.97]	
Value of all loans repaid in cashews	8759.37	4863.84*	1595.68	3268.17	0.09
	(37199.69)	(2648.63)	(1850.78)	(2809.38)	1988
		[0.07]*	[0.39]	[0.25]	
1 if borrowed money or rice in any month	0.35	-0.00	0.04	-0.05*	0.10
	(0.48)	(0.03)	(0.03)	(0.03)	1987
		[0.92]	[0.13]	[0.07]*	
Total amount paid for loans in any month	27.65	15.66*	8.38	7.28	0.09
	(114.39)	(8.00)	(6.02)	(8.70)	1987
		[0.05]*	[0.17]	[0.40]	
1 if sold most to local buyer	0.37	0.00	0.02	-0.02	0.06
	(0.48)	(0.03)	(0.03)	(0.03)	1984
		[0.96]	[0.49]	[0.51]	
1 if sold most to itinerant buyer	0.55	-0.00	-0.02	0.02	0.05
	(0.50)	(0.03)	(0.03)	(0.03)	1984
		[0.89]	[0.42]	[0.49]	
1 if sold most directly to a market	0.06	0.00	0.01	-0.00	0.02
	(0.24)	(0.01)	(0.01)	(0.01)	1984
		[0.93]	[0.67]	[0.74]	
1 if has a fixed buyer	0.30	0.05*	0.03	0.02	0.10
	(0.46)	(0.03)	(0.03)	(0.03)	1987
		[0.07]*	[0.29]	[0.50]	

Notes: Coefficient of treatment and spillover at baseline (Columns 2-3). Column 3 shows the results of tests for differences in parameters obtained in previous two columns. Column 4 reports the standardized pairwise maximum difference between means across all study groups. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. p-values reported in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number of observations.

Table 14: Baseline balance – Producer Characteristics

	Control (1)	(2)	(3)	(4)	(5)
	Mean (SD)	Treatment	Spillover	Treat. vs. spillover	Max pairwise st. diff. Total obs.
Producer-level characteristics					
1 if a woman	0.05	0.00	-0.00	0.00	0.02
	(0.23)	(0.01)	(0.01)	(0.01)	1985
		[0.92]	[1.00]	[0.90]	
Age	43.47	-1.06	-1.11	0.05	0.06
	(14.96)	(0.79)	(0.77)	(0.75)	1988
		[0.18]	[0.15]	[0.95]	
Household size	13.40	0.57	1.02*	-0.45	0.08
	(7.88)	(0.54)	(0.57)	(0.41)	1988
		[0.30]	[0.08]*	[0.27]	
Years of education	3.89	0.01	-0.10	0.11	0.04
	(3.77)	(0.23)	(0.23)	(0.18)	1988
		[0.95]	[0.67]	[0.54]	
1 if Kriol is the most spoken language at home	0.21	-0.01	-0.01	0.00	0.05
	(0.41)	(0.02)	(0.02)	(0.02)	1988
		[0.72]	[0.63]	[0.89]	
1 if cashews are the main source of income	0.79	0.02	0.00	0.02	0.06
	(0.41)	(0.02)	(0.02)	(0.02)	1988
		[0.29]	[0.97]	[0.33]	
Area plantation	3.26	0.28**	0.27*	0.01	0.11
	(2.29)	(0.13)	(0.14)	(0.15)	1988
		[0.04]**	[0.06]*	[0.97]	
Years of experience in cashew sector	10.17	0.65*	0.25	0.41	0.08
	(7.05)	(0.39)	(0.38)	(0.38)	1988
		[0.09]*	[0.52]	[0.28]	
Index of numeracy (Anderson, 2008)	0.00	0.10*	0.02	0.08	0.11
	(1.00)	(0.06)	(0.06)	(0.05)	1988
		[0.08]*	[0.75]	[0.14]	
1 if can read	0.29	0.00	0.00	-0.00	0.02
	(0.45)	(0.03)	(0.03)	(0.02)	1988
		[0.90]	[0.86]	[0.95]	
Extremely risk averse	0.55	-0.02	0.01	-0.03	0.07
	(0.50)	(0.02)	(0.03)	(0.03)	1959
		[0.41]	[0.59]	[0.22]	
Number of buyers that made offers	2.68	0.19*	0.05	0.13	0.16
	(1.71)	(0.10)	(0.10)	(0.10)	1981
		[0.06]*	[0.59]	[0.18]	
1 if trusted the official reference price	0.36	0.03	0.03	0.01	0.07
	(0.48)	(0.02)	(0.03)	(0.03)	1988
		[0.15]	[0.30]	[0.78]	
1 if faced storage limitations	0.27	0.06**	0.02	0.04*	0.15
	(0.45)	(0.03)	(0.02)	(0.02)	1988
		[0.01]**	[0.40]	[0.08]*	
Delayed sales expecting price increases	0.72	0.00	-0.01	0.02	0.04
	(0.45)	(0.02)	(0.02)	(0.03)	1984
		[0.82]	[0.58]	[0.48]	
Told received price offers to N producers	5.85	0.81**	1.70***	-0.89*	0.19
	(6.84)	(0.34)	(0.48)	(0.54)	1878
		[0.02]**	[0.00]***	[0.10]*	
Told price offers by N producers	4.80	0.59**	0.76**	-0.18	0.11
	(5.73)	(0.28)	(0.33)	(0.38)	1863
		[0.03]**	[0.02]**	[0.64]	

Notes: Coefficient of treatment and spillover at baseline (Columns 2-3). Column 3 shows the results of tests for differences in parameters obtained in previous two columns. Column 4 reports the standardized pairwise maximum difference between means across all study groups. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. p-values reported in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number of observations.

Table 15: Balance – Producer (continued) and Village Characteristics

	Control (1) Mean (SD)	(2) Treatment	(3) Spillover	(4) Treat. vs. spillover	(5) Max pairwise st. diff. Total obs.
Producer-level characteristics					
Minimum price at which sold most cashews in the last 3 years	318.64	-5.68	-1.93	-3.75	0.06
	(88.85)	(4.22)	(4.70)	(4.40)	1988
		[0.18]	[0.68]	[0.39]	
Expected price for season 2020	819.62	8.09	-0.70	8.78	0.04
	(312.12)	(23.26)	(21.04)	(37.43)	1987
		[0.73]	[0.97]	[0.81]	
Desired reference price for 2020	1042.00	-16.38	14.87	-31.25	0.09
	(297.53)	(16.78)	(22.31)	(23.25)	1988
		[0.33]	[0.51]	[0.18]	
Minimum age of trees	3.32	-0.06	0.08	-0.14	0.06
	(3.43)	(0.17)	(0.20)	(0.20)	1966
		[0.74]	[0.68]	[0.49]	
Max age of trees	17.23	-0.20	0.04	-0.25	0.04
	(8.41)	(0.47)	(0.48)	(0.48)	1868
		[0.67]	[0.93]	[0.61]	
1 if trees were diseased	0.69	-0.03	-0.01	-0.03	0.08
	(0.46)	(0.03)	(0.03)	(0.03)	1980
		[0.20]	[0.78]	[0.32]	
1 if sells other crops	0.65	0.09***	0.10***	-0.01	0.21
	(0.48)	(0.02)	(0.02)	(0.02)	1988
		[0.00]***	[0.00]***	[0.76]	
Index of trust (Anderson, 2008)	-0.00	0.07	0.07	-0.00	0.05
	(1.00)	(0.05)	(0.05)	(0.06)	1988
		[0.18]	[0.21]	[0.99]	
Village-level characteristics					
Number of cashew producers in the village	33.27	0.43	-2.14	2.57	0.19
	(23.38)	(3.60)	(3.00)	(3.63)	288
	288	[0.91]	[0.48]	[0.48]	
Road distance in km to nearest sector capital	26.00	-1.02	3.75	-4.77	0.16
	(23.99)	(3.23)	(2.96)	(3.33)	290
	290	[0.75]	[0.21]	[0.15]	
Road distance in km to nearest region capital	51.87	-3.97	3.34	-7.31	0.03
	(33.98)	(3.89)	(4.26)	(5.53)	290
	290	[0.31]	[0.43]	[0.19]	
Road distance in km to the capital	160.49	3.75	4.69	-0.94	0.13
	(69.45)	(6.62)	(6.66)	(9.65)	290
	290	[0.57]	[0.48]	[0.92]	

Notes: Coefficient of treatment and spillover at baseline (Columns 2-3). Column 3 shows the results of tests for differences in parameters obtained in previous two columns. Column 4 reports the standardized pairwise maximum difference between means across all study groups. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. p-values reported in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number of observations.

Table 16: Attrition in May 2021 – In-Person Endline Survey

	Control (1) Mean (SD)	(2) Treatment	(3) Spillover	(4) Treat. vs. spillover	(5) Max pairwise st. diff. Total obs.
1 if attrited at endline	0.13	0.01	0.00	0.00	0.05
	(0.33)	(0.02)	(0.02)	(0.02)	1988
		[0.66]	[0.80]	[0.90]	

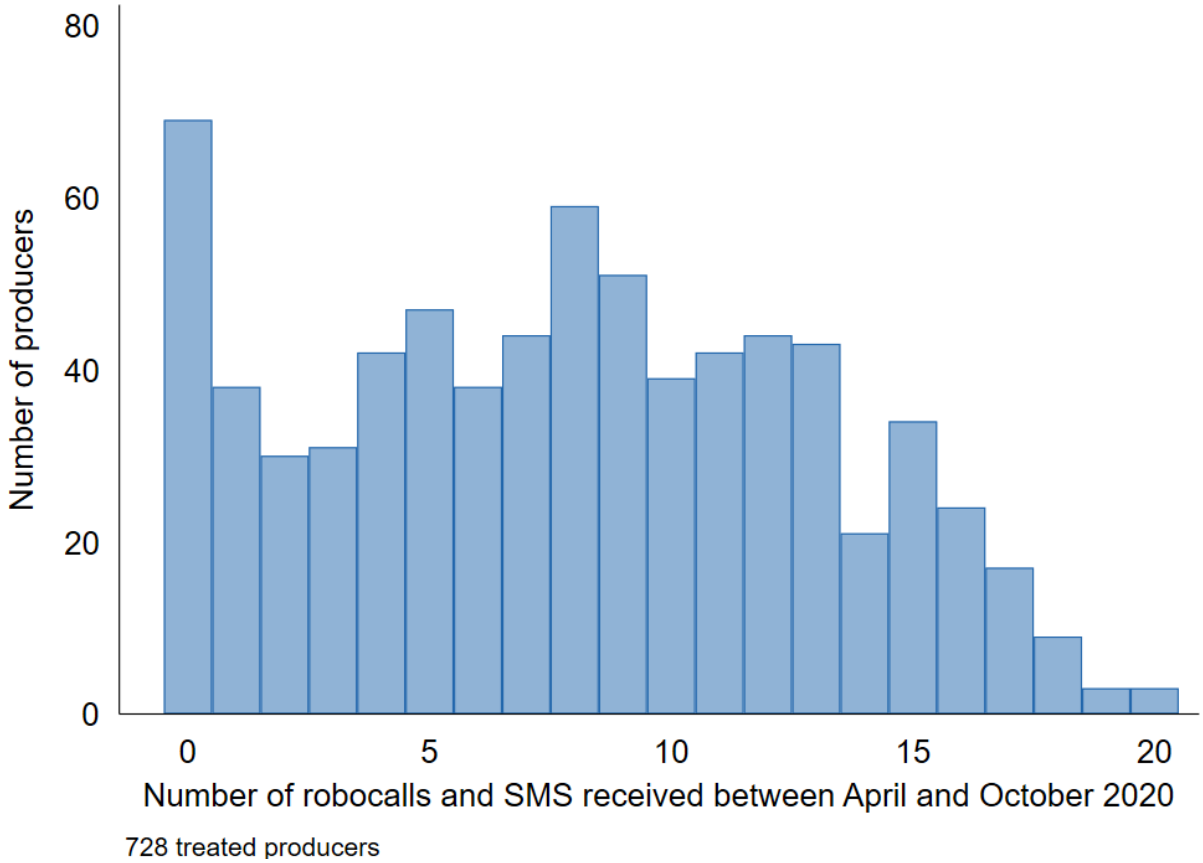
Notes: Coefficient of treatment and spillover at baseline (Columns 2-3). Column 3 tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. p-values reported in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number of observations.

Table 17: Compliance – Take-Up of the Intervention using MTN Administrative Data

	Control (1) Mean (SD) Total obs.	(2) Treatment	(3) Spillover	(4) Treat. vs. spillover
1 if received at least 8 messages in 2020 (Take-up)	0.00	0.53***	0.00	0.53***
	(0.00)	(0.02)	(0.01)	(0.03)
	1719	[0.00]***	[0.90]	[0.00]***

Notes: Coefficient of treatment and spillover at endline (Columns 2-3). Column 4 tests for differences in parameters obtained in previous two columns. Outcome variable listed on the left. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Minimum p-values reported in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, and total number of observations.

Figure 4: Number of Robocalls and SMS Received By Treated Producers Using MTN Administrative Data



A.2 Additional Analysis of Average Treatment Effects

Table 18: Results – Additional Quantity-Related Outcomes

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
1 if perceived production increased in 2020 relative to 2019	0.33	-0.01	0.00	-0.01	-0.02	0.00	-0.02
	(0.47)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1707	[0.92]	[0.99]	[0.75]	[0.92]	[0.99]	[0.85]
1 if perceived production decreased in 2020 relative to 2019	0.56	0.01	0.01	0.00	0.01	0.01	0.01
	(0.50)	(0.03)	(0.03)	(0.03)	(0.05)	(0.03)	(0.04)
	1707	[0.92]	[0.99]	[0.98]	[0.92]	[0.99]	[0.87]
Total quantity of cashews paid to labourers	162.72	8.85	-0.25	9.10	16.77	-0.31	17.08
	(261.04)	(17.21)	(16.03)	(14.24)	(32.57)	(15.94)	(25.68)
	1421	[0.92]	[0.99]	[0.75]	[0.92]	[0.99]	[0.85]
Total quantity of cashews used for other purposes	0.27	0.23	-0.01	0.24	0.43	-0.00	0.44
	(3.92)	(0.29)	(0.29)	(0.32)	(0.54)	(0.29)	(0.51)
	1683	[0.92]	[0.99]	[0.75]	[0.92]	[0.99]	[0.85]
Total quantity of cashews stored	0.60	-0.35	-0.43	0.08	-0.66	-0.43	-0.23
	(10.70)	(0.31)	(0.39)	(0.14)	(0.59)	(0.39)	(0.26)
	1679	[0.92]	[0.94]	[0.75]	[0.92]	[0.94]	[0.85]
Quantity traded in small weekly exchanges	62.83	-0.10	3.10	-3.19	-0.18	3.10	-3.27
	(107.87)	(6.17)	(6.84)	(6.44)	(11.39)	(6.84)	(9.82)
	1604	[0.99]	[0.99]	[0.75]	[0.99]	[0.99]	[0.86]

Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, total number control mean, standard deviation, and total number of observations across all groups.

Table 19: Results – Additional Information-Sharing Outcomes

	Control	ITT			TOT		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean (SD) Total obs.	Treatment	Spillover	Treat. vs. spillover	Treatment	Spillover	Treat. vs. spillover
Number of producers informed of an offer received from the same village	5.07	0.23	0.19	0.04	0.43	0.19	0.23
	(5.91)	(0.33)	(0.33)	(0.30)	(0.61)	(0.33)	(0.49)
	1563	[0.48]	[0.56]	[0.90]	[0.48]	[0.56]	[0.76]
Number of producers informed of an offer received from other villages	1.67	0.29	0.19	0.11	0.54	0.18	0.36
	(2.94)	(0.18)	(0.19)	(0.22)	(0.33)	(0.19)	(0.33)
	1540	[0.21]	[0.44]	[0.82]	[0.21]	[0.44]	[0.55]
Number of producers that shared price offers from the same village	3.63	0.52**	0.28	0.24	0.98**	0.28	0.70*
	(7.45)	(0.26)	(0.26)	(0.24)	(0.50)	(0.27)	(0.41)
	1546	[0.18]	[0.44]	[0.82]	[0.20]	[0.44]	[0.34]
Number of producers that shared price offers from other village	1.20	0.21	0.31*	-0.10	0.39	0.31*	0.09
	(2.40)	(0.16)	(0.18)	(0.19)	(0.30)	(0.18)	(0.29)
	1533	[0.26]	[0.33]	[0.82]	[0.26]	[0.33]	[0.76]

Notes: Notes: Intention-to-treat (ITT) estimates are reported in Columns 2 and 3, and treatment-on-the-treated (TOT) estimates are reported in Columns 5 and 6 where take-up is instrumented by treatment assignment. Columns 4 and 7 show results of tests for differences in parameters obtained in previous two columns. Outcome variables are listed on the left and described in detail in the pre-analysis plan. The unit of observation is the individual producer. All models control for randomization triplet fixed-effects and the baseline value of the outcome when it was available. Standard errors are in parentheses and are clustered at the village-level. Asterisks on the coefficient estimates reflect unadjusted p-values. Sharpened q-values controlling the false discovery rate across outcomes within each family are shown in brackets. Significance levels: *10%, **5%, and ***1%. Column 1 displays the control mean, standard deviation, total number control mean, standard deviation, and total number of observations across all groups.

A.3. Costs of Production

The production costs relate to the payment of labor for two main activities: preparing the fields and collecting the nuts. Fields where cashew trees grow must be cleaned to improve access to the nuts (or nuts and fruits) that have fallen from the trees. Family or hired seasonal labor is hired to clean the fields before the cashew fruit are ripe and start falling. For the product to be ripe and of good quality, the fruit should be gathered after it has fallen from the tree, and the second activity therefore involves actually collecting the fallen cashew fruit. Occasionally, credit-constrained producers may collect cashew fruit directly from the trees, but this means that the nut has not fully absorbed all nutrients from the tree and is smaller and of lower quality. Labor costs are often measured imprecisely, especially since they are often paid in-kind using a rule-of-thumb type of payment (e.g. every third day, the collection goes to the laborers) or through shared meals.

A.4. Weekly Messages

Table 20: Results—Messages Sent During the 2020 Cashew Marketing Season

Date sent	Format	English translation
01 April 2020	SMS 1	The BELAB and the *n'kalô* service will send you information each week on the cashew nut market. Because voice-messages are not yet ready, we will send you an SMS.
01 April 2020	SMS 2	The opening of the campaign was delayed because of coronavirus. We advise you to wait to sell until the confusion is over. Keep cashew nuts dry to maintain quality.
16 April 2020	SMS 3	The opening of the campaign has been further delayed because of coronavirus. Wait to sell until the campaign opens and until the price goes above 300 XOF. Keep cashew nuts dry to maintain quality.
28 April 2020	SMS 4 (placebo)	BELAB/*n'kalô* that interviewed you in 2019 wishes you a good cashew-trading season. Remember to complete your sales diary in order to take part in the lottery at the end of the season.
28 April 2020	SMS 5	Reference price was announced as 375 XOF/kg. Official opening is still delayed because of the state of emergency. Keep cashew nuts dry to maintain quality.
08 May 2020	SMS 6	Port is still closed because of coronavirus. We think the price will increase in the next few weeks, so wait until the price reaches 375 XOF/kg or more to sell.
16 May 2020	Robocall 1	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts this year. Each week, we will send messages to keep you informed about the market situation and prices. The official launch of the cashew marketing campaign is still delayed because of the

		coronavirus epidemic. But the campaign is due to launch in a few weeks. In neighboring countries like Senegal, Gambia, and Guinea-Conakry, prices have increased in recent weeks. In fact, cashew processors in India and Vietnam are short of cashews and need it in the coming months. Prices in other countries have risen above 350 XOF/kg. We believe that as soon as the campaign really starts, prices will go up a lot; therefore, we recommend that you dry cashew nuts well and maintain your stocks until prices rise in June. See you next week.
21 May 2020	Robocall 2	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts this year. Each week, we will send messages to keep you informed about the market situation and prices. Unfortunately, the official launch of the cashew trade campaign has been delayed. It shouldn't be too late, but no date is known yet. Despite this, prices started to rise this week because of high demand in the international market. In Biombo, Cacheu, and Oio, prices range from 250 to 300 XOF/kg, in Gabu the prices fixed at 250 XOF/kg and remain the same as last week, in Bafata, Bolama, Quinará, and Tombali, where the price is also at 250 XOF/kg. In neighboring countries Senegal, Gambia, and Guinea Conakry, prices have exceeded 350 XOF/kg. We recommend that you wait and start selling your product only if the price offered to you reaches 375 XOF/kg or more.
29 May 2020	Robocall 3	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts this year. This week, the cashew trade campaign was finally officially launched. Since the campaign starts late, it is also likely to end late. It will take a few more weeks for exporters from the port of Bissau to start shipping cashews on ships to India and Vietnam. The demand for Guinea-Bissau cashews is very strong there and, therefore, we believe prices will increase in the coming weeks. Currently, in the regions of Bafata, Gabu, Bolama, Quinará, and Tombalí, prices have remained at 250 XOF/kg and in Oio, prices still vary between 250 300 XOF/kg. On the other hand, in Cacheu, prices started to rise and are between 300-350 XOF/kg, while in Biombo, the price increase is even stronger and sales are made between 350-375 XOF/kg. With competition that will rise, we believe that prices will still rise but in the coming weeks. In order not to take too much risk, but to take advantage of the price increase, we advise all producers to wait until 375 XOF/kg is offered before selling the first half of their production and keep the other half selling later when prices can still be higher. We remind you that in Senegal and The Gambia, prices exceed 400 XOF/kg. So hope and have a good week!
11 June 2020	SMS 7	Prices are still rising. We advise you to sell half of your stock if prices reach 375 XOF/kg or more and sell the rest later.
17 June 2020	Robocall 4	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts this year. The marketing of cashew nuts is intensifying across the country and, in recent days, representatives of Indian and Vietnamese buyers have started to arrive in the country to check the quality. This week's prices have not changed much from last week. The purchase prices of producers remain between 300 and 350 XOF/kg in the regions of Bafata, Bolama, Gabu, Oio, Quinara and Tombali. Higher prices are practiced in Biombo regions,

		where sales of 375 XOF/kg are made and in Cacheu, where prices reach up to 400 XOF/kg in locations close to Senegal. At the port of Bissau, cashew nuts trucks are paid between 380 and 420 XOF/kg, depending on the quality of the nuts. When the nuts are very dry, they are more expensive. With increasing competition between buyers, we continue to think that prices will increase slightly in the coming weeks and we always advise you to store cashews until the price of 375 XOF/kg is offered and to sell half of your stocks when that price is offered. Good week to everyone.
25 June 2020	Robocall 5	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts this year. Large quantities have arrived in Bissau since the campaign was launched. This slightly reduced demand at the port caused a slight drop in prices for cashew trucks delivering to the port of Bissau. As a result, producer prices have fallen slightly in some areas of production and are stable in others. Currently, prices are between 300 and 325 XOF/kg in the regions of Bafata and Gabu and between 300 and 350 XOF/kg in all other regions of the country. With the coronavirus epidemic still a problem in many countries around the world, cashew buyers have reduced their orders. Unlike the past few weeks, we are no longer sure that prices will rise. That is why we recommend that you sell most of your nuts if the prices offered are higher than 325 XOF/kg.
01 July 2020	Robocall 6	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts this year. This week, the first shipment has already left the ports of Bissau, bound for India. Despite these first exports, there is still a lot of stock in the port of Bissau and, therefore, exporters are not in a hurry to buy. Above all, they want to export the nuts they have in their stores before placing further orders with traders in the production areas. That is why prices practically do not change, always with sales between 300 and 350 XOF/kg in the areas of cashew production. We always recommend selling most of your nuts if a price of 325 XOF/kg or more is offered because with the situation of the COVID virus, we do not know how prices will evolve in the coming weeks.
14 July 2020	Robocall 7	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts this year. This week, there was a certain slowdown in terms of cashew nut transactions in Bissau. Traders have reduced deliveries and are demanding higher prices from exporters. But at the same time, demand from the Vietnam and India factories remains low and cashew nut prices have fallen in Senegal, Gambia, and the Ivory Coast. In certain regions of Guinea-Bissau, prices have also fallen a little. In the regions of Bolama, Quinara and Tombali, prices remained at 300 XOF/kg; in the regions of Bafata and Gabu, prices vary between 250-350 XOF/kg; in Biombo and Oio, prices are between 300-350 XOF/kg, and in Cacheu, there were slight increases of 25 XOF in prices, with variations between 325-375 XOF/kg. We recommend selling most of the production when a price of 325 XOF/kg or more is offered to you.
16 July 2020	Robocall 8	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the marketing of cashew nuts this year. This week, new exporters started to buy cashew nuts which increased demand at the port. Prices rose marginally at the port of Bissau. The prices at the port averaged between 375 and 390

		CFA/kg, whereas last week they were between 370 and 380 CFA/kg. This increase in demand also increased producer prices. In the regions of Bafata, Gabu, Oio and Bolama the producer price is around 300 XOF/kg. In Quinará and Tombali, producer prices are between 300 and 325 XOF/kg, slightly better than the previous week. In Biombo, certain producers can sell at up to 330 XOF/kg; however, in Cacheu, prices are between 350 and 375 XOF/kg. As we did last week, we recommend that you sell most or all production when a price of 325 XOF/kg or more is offered to you. See you later"
22 July 2020	Robocall 9	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts. This week, the competition between nut exporters in Bissau port further increased, and prices reached 400 XOF/kg. The producer prices also slightly increased. Higher prices continue to be paid in Cacheu, where producer prices are between 350 and 375 XOF/kg. In the regions of Bafata, Bolama, Gabu, Biombo, and Oio, prices are between 300 and 350 CFA/kg—an increase of between 10 and 50 CFA/kg. Lower prices are paid in Quinara and Tombali where cashews are purchased for between 300 and 325 CFA/kg. This increased demand is an excellent opportunity to try to negotiate a good price for the cashew nuts you still have. We recommend negotiating a price of 350 XOF/kg to sell all remaining inventory. See you next week.
31 July 2020	Robocall 10	Dear Stakeholders in the Cashew Sector: This is André Nanque, from N'kalô, to talk about the commercialization of cashew nuts. This week, the competition between nut exporters in the port of Bissau continues to be great and the prices also increased slightly. The prices productor also increased slightly in the production zones. The highest prices in Cacheu productor reached between 350 and 400 XOF/kg. In the regions of Bafata, Biombo, Bolama, Oio, and Gabu prices were 350 XOF/kg, which was the same price of last week. In the regions of Quinara and Tombali the price increase was strong. In these two regions the prices went from 300 and 325 XOF/kg last week to 350 and 375 XOF/kg this week. The campaign will end in a few weeks. We therefore recommend negotiating a minimum price of 350 XOF/kg to sell all remaining stocks. You can get a good price without waiting too much more to sell. See you next week.
06 August 2020	Robocall 11	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts. This week, the marketing campaign cashews is near the end in the regions of Bafata, Biombo, Bolama, and Oio where the last prices paid to Producers were 350 XOF/kg. Quinara and Tombali persist in high demand for cashew nuts and prices paid are between 350 and 375 XOF/kg as they were last week. In Cacheu, cashew nuts are still purchased between 375 and 400 XOF/kg, but only a limited quantity is available. In the port of Bissau, the competition fell slightly and prices decreased slightly. International demand is limited at this point so it is very unlikely that prices will keep increasing. Our advice is to sell the nuts that you still have as fast as possible. See you next week"
13 August 2020	Robocall 12	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts. This week, the cashews commercialization campaign finished in the regions of Bafata, Biombo, Bolama and Oio, where heavy rain

		began and the few available stocks made trading very difficult. In Quinara and Tombali, there is still demand for cashews with stable prices between 350 and 375 XOF/kg. In Cacheu, nuts are still purchased at between 375 and 400 XOF/kg. In the port of Bissau, competition increased slightly and prices also marginally increased. International demand is limited at this point which makes an increase in prices very unlikely. Our advice and sell the nuts that are with you as fast as possible. See you next week"
22 August 2020	Robocall 13	Dear Stakeholders in the Cashew Sector: This is André Nanque, from *n'kalô*, to talk about the commercialization of cashew nuts. This week the marketing season ended in all cashew producing regions. Almost all seasonal trading points of intermediaries from producers have closed, with no purchase and sales of cashew nuts recorded inside the country, throughout the week. The latest sales took place in the capital, Bissau, between traders and exporters with a price between 400 and 430 XOF/kg. As such, we'll stop sending weekly messages starting next week. We hope you have enjoyed our information. We will work to continue to inform you from the beginning of the next cashew marketing season. Until next year!
09 September 2020	SMS 8 (placebo)	BELAB/*n'kalô*, who interviewed you in 2019, remind you to keep your sales diary in order to take part in the lottery before the next marketing season.

A.5. Changes between the 2019 and 2020 Seasons

How Did the Raw Cashew Nut Market React to the Pandemic in 2020?

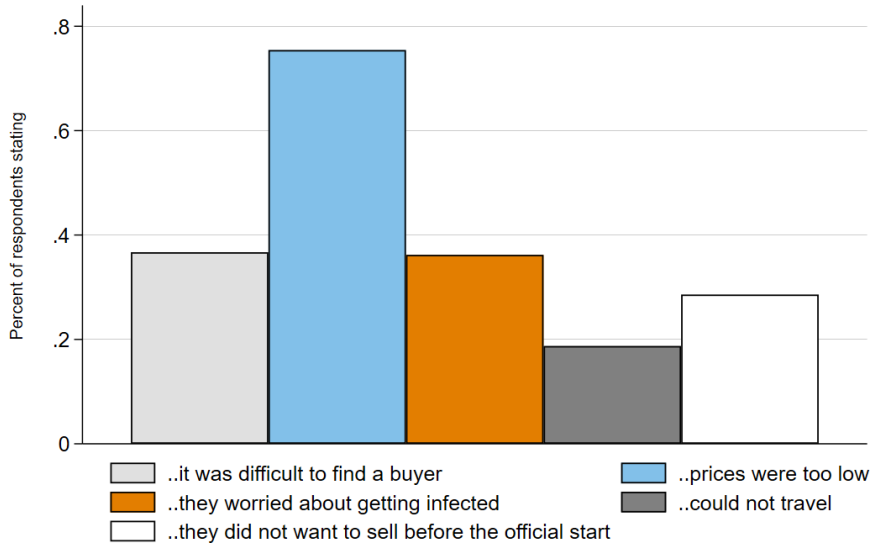
The cashew-trading season in Guinea-Bissau generally starts in late March. In 2020, as the result of restrictions imposed by the government, the official start of the season was postponed until May 27.[34] As a result of liquidity needs, little bargaining power, and high uncertainty, many producers had to start selling their cashews before the official start of the cashew-marketing season, at prices as low as 200 XOF/kg (US$ 0.34/kg) compared to a national average of 474 XOF/kg (US$ 0.81/kg) in 2018 and 351 XOF/kg (US$ 0.60/kg) in 2019.

However, some producers decided to postpone their planned cashew sales because of COVID-19 implications. Of the producers we contacted during a short phone-survey between July and September 2020, 69% stated that they delayed their cashew sales against their original intentions because of the COVID-19 pandemic. Most reported

[34] It is technically unlawful to sell or purchase raw cashew nuts before the government announces the official start of the trading season.

that price offers were too low, that they had difficulties in finding a buyer, or that they were worried about getting infected (see Figure 5).

Figure 5: Reasons for Delaying Cashew Sales in 2020



The large drops in price and in quantities of cashew nuts sold in 2020 resulted in a dramatic fall in revenue compared to previous years.

A.6. Comparison of the 2019 and 2020 Trading Seasons

In this section, we analyze data from the sample of producers in the 103 control villages in which no new market information system was introduced.[35] We report their outcomes collected over two in-person interviews conducted between November and December 2019 and later between April and May of 2021. In those interviews, we asked producers about their cashew sales and other indicators in relation to the 2019 and 2020 trading seasons, respectively.[36]

During the first round of interviews in 2019, we interviewed 694 producers across

[35] These villages were randomly chosen to be the comparison group for our impact evaluation of a market information system. We had randomly chosen them to *not* receive this intervention during 2020.
[36] The responses were unlikely to be affected by seasonality effects, despite the timing of the interviews across the two rounds, because we asked respondents about their cashew trades during the prior trading season, which occurs around the same time each year. Concretely, during the interviews we conducted in 2021, we asked respondents about their trades in 2020. April and May are usually the first months of the cashew trading season, whereas November and December are pre-harvest months for cashew producers.

103 villages. Of these, 87 producers could not be reached when we conducted the second round of in-person interviews in 2021, an attrition rate of 12%.

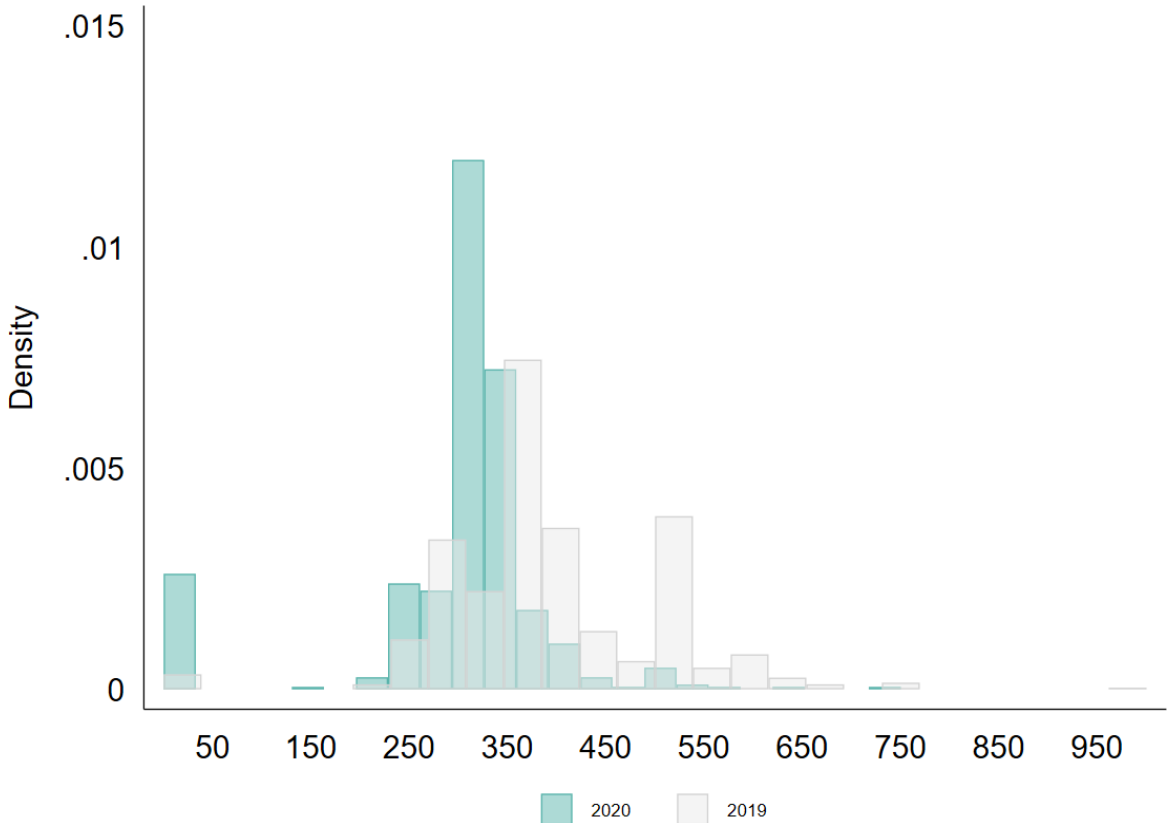
Table 21: Timing of Sales in 2019 and 2020

	(1) 2019	(2) 2020	(3) (1) - (2) *p*-value	(4) N
1 if sold cashews in April or before	0.20	0.15	0.05	
	(0.40)	(0.35)	[0.02]	521
1 if sold cashews in May	0.51	0.51	-0.00	
	(0.50)	(0.50)	[0.90]	521
1 if sold cashews in June	0.55	0.49	0.05	
	(0.50)	(0.50)	[0.07]	521
1 if sold cashews in July or later	0.19	0.07	0.12	
	(0.39)	(0.25)	[0.00]	521

Notes: Column 1 reports the mean in 2019. Column 2 reports the mean in 2020. Outcome variables are listed on the left. Standard deviations are reported in parentheses. Columns 3 reports the difference between columns 1 and 2 and the p-value from a t-test of equality between the means between 2019 and 2020 in brackets.

In 2020 a lower percentage of producers sold any cashews in the month of April or earlier, as can be seen in Table 21, relative to 2019, because of the delayed start of the official trading season. However, cashew-nut transactions still took place before the official start of the season (May 27, 2020): 15% of the sample sold in the month of April or earlier, and the percentage of producers who sold in the month of May was the same in 2019 and in 2020. A lower percentage of producers sold any cashews after the month of May compared to the same period in 2019.

Figure 6: Histogram of Average Cashew Prices in 2019 and 2020



The distribution of the average price received by interviewed producers in 2020 shifted to the left in comparison to the same distribution for 2019 (see Figure 6, which shows that 2020 prices were more concentrated and lower on average than in 2019). We also found that the proportion of producers who made no sales was higher in 2020 than in 2019, as shown by the bar on the left of the histogram.[37]

Table 22 shows that the reduction in prices during the pandemic also contributed to a reduction in the revenue earned by producers relative to 2019. Average prices per kg fell by 24% on average between 2019 and 2020. The decrease in revenue from cashew transactions declined even further, falling by 47% in relative terms in comparison to pre-pandemic levels. The drop in revenue was fully accounted for by monetary sales and from changes in the value of cashews bartered for rice.[38] On the contrary, we observed that the value producers obtained from cashew exchanges was higher in 2020 relative to

[37] We recoded the price to zero for producers who conducted no sales.
[38] It is common for producers to barter cashew nuts for rice, especially when cashew prices fall to levels that are close to the price of rice per kg, which makes the conversion easier to process.

2019, though far from enough to compensate for lower sales revenue, given that the value of sales declined by 50.8%.

Table 22: Prices and revenue from Sales and Exchanges in 2019 and 2020

	(1) 2019	(2) 2020	(3) (1) - (2) *p*-value	(4) N
Price per sale per kg	389	295	94	
	(104)	(105)	[0.00]	564
Value of all sales and exchanges	511,949	271,023	240,925	
	(880,506)	(310,374)	[0.00]	594
Value of all sales	474,793	233,494	241,298	
	(869,688)	(292,721)	[0.00]	564
Value of exchanges	37,939	52,325	-14,386	
	(83,559)	(88,037)	[0.00]	589

Notes: Column 1 reports the mean in 2019. Column 2 reports the mean in 2020. Outcome variables are listed on the left. Standard deviations are reported in parentheses. Columns 3 reports the difference between columns 1 and 2 and the p-value from a t-test of equality between the means between 2019 and 2020 in brackets. All values are in West African CFA.

Two patterns emerge from comparisons across trading seasons of the quantities of cashew nuts produced and used for different purposes. First, a much higher quantity was produced and sold overall in 2019 than in 2020. The average production by farmer went down by 394 kg, a 27% average reduction from 2019 to 2020, as shown in Table 23. The drop in production might be explained by worse agronomic conditions in 2020 relative to the previous year.

Second, a much higher percentage of producers exchanged cashews for rice, both on the extensive and intensive margins. On the extensive margin, the percentage of farmers bartering cashew nuts increased from 30% in 2019 to 56% in 2020. On the intensive margin, the average quantity exchanged by farmers increased by 103 kg, or 91% in 2020 relative to 2019. As a result, the average quantity sold decreased by even more than the total quantity produced, from 1,194 kg (or 81% of total production) to 708 kg (or 65% of total production). This 486 kg drop in sales represents 41% of the average quantity sold in 2020.

The last three rows in Table 23 provide an explanation for how producers reacted

to the downturn in both cashew prices and production by either borrowing or engaging in alternative activities to diversify sources of income.

The percentage of producers who received credit, either in money or rice, decreased from 37% in 2019 to 31% in 2019. In the same direction, the value of the loans repaid in cashews decreased from 16,294 XOF to 12,994 XOF, but this difference was not statistically significant. The reduction in credit between 2019 and 2020 may be the result of either supply-side or demand-side factors. On the demand-side, the perspective of a poor trading season reduces the expected value of cashews, which can reduce demand for credit as producers' collateral falls in value. On the supply-side, a worsening market outlook for cashew nuts can reduce the liquidity of informal loan providers in Guinea-Bissau, who are often involved in the cashew-nut value chain as either intermediaries or exporters.[39]

[39] Many exporters who financed loans to intermediaries and producers could not reach the country because of the closed international borders. The lack of credit was only partly relaxed by the government, which stepped in to provide a five billion XOF loan to national banks to finance trades after the cashew season had started.

Table 23: Quantities in 2019 and 2020

	(1) 2019	(2) 2020	(3) (1) - (2) *p*-value	(4) N
Total quantity produced	1473 (1935)	1079 (1000)	394 [0.00]	444
Total quantity sold	1194 (1772)	708 (85)	486 [0.00]	569
1 if exchanged cashews for rice	0.30 (0.46)	0.56 (0.50)	-0.26 [0.00]	604
Total quantity exchanged	114 (248.78)	218 (323.48)	-103 [0.00]	599
1 if borrowed money or rice	0.37 (0.48)	0.31 (0.46)	0.06 [0.03]	603
Value of all loans repaid in cashews	16,295 (47,354)	12,995 (66,460)	3,300 [0.32]	602.00
1 if sold other crops	0.67 (0.47)	0.97 (0.18)	-0.30 [0.00]	607

Notes: Column 1 reports the mean in 2019. Column 2 reports the mean in 2020. Outcome variables are listed on the left. Standard deviations are reported in parentheses. Columns 3 reports the difference between columns 1 and 2 and the p-value from a t-test of equality between the means between 2019 and 2020 in brackets. Quantities are in metric kg and the value of loans is in West African CFA.

A higher share of producers diversified their portfolios, as a likely coping mechanism producers adopted in 2020 to deal with a worse cashew market: the percentage of farmers selling crops different from cashew increased from 67% in 2019 to 97% in 2020. This indicates an important substitution effect between cashew revenue and trading of alternative crops, at least on the extensive margin.