INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
IFPRI

PROJECT NOTE | DECEMBER 2018

DEMAND FOR AFLATOXIN-SAFE MAIZE IN KENYA

Dynamic response to price and advertising

VIVIAN HOFFMANN, CHRISTINE MOSER, AND TIMOTHY HERRMAN

1. INTRODUCTION

This paper characterizes consumer demand for food safety and the dynamic impact of a social marketing campaign to promote a tested, third party verified maize flour in Kenya, where dietary exposure to the fungal toxin aflatoxin is a major public health concern. Consumption of high levels of aflatoxin can be fatal, but this is relatively rare. Of greater concern is chronic exposure, which has been linked in numerous studies to liver cancer and may also contribute to child stunting. A significant proportion of the maize consumed in Kenya, where it is the primary dietary staple, fails to meet regulatory standards. One study reported widely in the Kenyan press found that 65% of maize samples collected from 20 major millers did not meet the national standard (Gathura, 2011) and another based on over 900 samples collected from retailers found that 26% of branded maize flour was above this standard (Hoffmann and Moser, 2017).

In markets with well-developed regulatory systems, safety is a requirement for market participation. In markets without effective food safety regulation, information on food safety is typically not available. The case of aflatoxin contamination in Kenya constitutes a unique research opportunity; firms are beginning to respond to consumer awareness of the toxin by investing in third-party verification of their testing processes and incorporating food safety claims in their marketing strategies. We partnered with the first firm in Kenya to subject its aflatoxin testing procedures to third party verification, and include a label indicating this on its product. Through a randomized field experiment, we estimate the dynamic impact on sales of an intermittent food safety-based marketing campaign for the labeled brand of maize flour.

In general, investment in preventive health technologies in developing countries is low for a variety of reasons, including lack of awareness about the effectiveness or cost effectiveness of prevention measures, liquidity and credit constraints, present-biased time preferences, and attention constraints (Dupas, 2011a; Kremer and Glennerster, 2011; Spears, 2014). However, compared to other health investments that often require discrete shifts in the use of time, attention or other scarce resources, selecting a safer maize flour brand requires only a minor change in behavior. Further, consumers are known to be less price sensitive to additional costs compared to stand-alone costs (Kahneman and Tversky, 1984), and purchasing safer food requires a relatively small marginal increase to an unavoidable outlay. Finally, food safety may be correlated with, or be perceived as correlated with, food attributes that are valued by consumers but difficult to observe ex ante, such as taste.

This paper makes two primary contributions to the literature on consumer health behavior. First, despite the immense burden of health exacted by the consumption of unsafe food in developing countries, which is estimated to rival that of malaria or tuberculosis (WHO, 2015), relatively little is known about consumer demand for food safety in these settings. While a number of studies have estimated willingness to pay for food safety, the majority of these use hypothetical elicitation methods and produce estimates ten to twenty times higher than those requiring actual payment by consumers (Ortega and Tschirley, 2017). Those studies that do require consumers to trade off either cash or an alternative food item against one labeled as “safe” analyze choices made immediately after researchers drew subjects’ attention to food safety (Ifft, Roland-Holst, and Zilberman 2012; Hoffmann and Gatobu, 2014; Birol, Roy and Torero, 2015). By temporarily increasing the salience of one particular attribute, this experimental design feature is also likely to produce upward-biased estimates of the value of food safety to consumers (Bordalo, Genaioli and Shleifer, 2013).

Second, we contribute to the literature on persistence of changes in health behavior. As for many preventive health behaviors, consumer demand for food safety will only have a significant impact on either firms' actions or consumer health if sustained over the long term. Several studies have described the dynamic market response to negative information about food safety, using food safety incidents and the resulting media coverage as natural experiments (Brown 1969; Johnson 1988; Burton and Young, 1997; Burton et al., 1999; Piggott and Marsh, 2004; Carter and Smith 2007). In general, these studies find that consumer demand for a product or product class drops sharply immediately following a negative information shock, and then gradually rebounds over a matter of months. In the case of sustained food safety risks, the long run impact on demand can be significant. Perhaps the case most analogous to aflatoxin on which long-run data is available is that of the risk of BSE in UK beef: both aflatoxin and BSE are substantiated and ongoing food safety hazards. Two separate studies utilizing different data and methodologies each estimated that five years after initial press reports about BSE, demand for beef as a share of total meat remained down by almost 5 percentage points (Burton and Young, 1997; Burton et al., 1999). Also related is a recent paper that analyzes how consumers' food choices respond to a shock about their own health status. Based on supermarket scanner data, this paper documents a small but significant decrease in purchased calories immediately following a diabetes diagnosis that fades to insignificance within a year (Oster, 2017).

The effect of a positive information shock about product safety is likely to differ from that of a negative shock. One reason is framing effects: in contexts associated with health losses, such as toxins in food, people tend to be more responsive to messaging focused on negative information (a brand or food shown to be particularly high-risk) than that focused on positive information (a brand that is relatively safe) (Rothman and Salovey, 1997). Another is the possible assumption that the safety of food products offered for sale by formal sector firms is effectively regulated.

In addition, the evidence we present relates to the larger question of how information affects human behavior. Standard economic models emphasize the cost of acquiring information (for example, Stigler, 1961; Nelson, 1970) and assume that once it is acquired, consumers use information indefinitely. However, models under which attention is a scarce resource imply that the impact of information may diminish over time as its salience fades (Banerjee and Mullainathan, 2008). The literature cited above on dynamic impacts of food safety scares and consumers' response to information about their own health status suggests that constraints to attention or willpower may limit the duration of consumer responses to health information.

In this paper, we test whether a health behavior can be sustained over time by repeatedly focusing attention on it through a social marketing campaign. Over a period of 12 weeks, either one or three intermittent week-long intensive marketing campaigns for an aflatoxin-tested maize flour brand were carried out at 49 shops in eastern Kenya. We compare sales of the target brand at these shops before, during, between and after the marketing campaigns to sales in 24 shops randomly assigned to a control treatment. While we detect an increase in sales of the target brand while the food safety marketing campaign is active, this impact disappears with the cessation of active marketing. In a randomly selected sub-set of shops where the marketing campaign included a temporary discount, the impact is longer-lasting, but also eventually fades.

The remainder of the paper is organized as follows. The next section provides background on the issue of aflatoxin contamination. Section 3 explains the study design and section 4 describes the data and presents the results. We discuss the implications of our findings in section 5.

2. BACKGROUND

2.1 Aflatoxin

Aflatoxin is a by-product of certain molds in the genus Aspergillus, and is a global problem that affects a wide range of crops. Maize and groundnuts are of particular concern because of their susceptibility to the fungus and the widespread consumption of these crops (Khlangwiset, Shephard, and Wu, 2011). Aflatoxin can be present in foods with no noticeable effect on taste, smell, or appearance.

Fungal growth depends both on conditions during cultivation and on post-harvest handling and storage practices. Drought, soil type, and pest infestations can make the crop more vulnerable to fungal infection pre-harvest. Post-harvest, conditions affecting growth include inadequate drying, length of storage, and poor storage conditions (Gnonlonfin et al., 2013). Even sufficiently dried foods can develop pockets of contamination during storage in the presence of insects, which can increase moisture through respiration (Williams et al., 2004). While in the developed world aflatoxin poses little risk to consumers because of systematic testing for aflatoxin and modern processing and storage technologies, billions of people may be exposed to potentially dangerous levels of aflatoxin in the developing world (Williams et al., 2004; Strosnider et al., 2006).

Consumption of high levels of aflatoxin can be fatal, but deaths from acute aflatoxin poisoning are rare (Williams et al. 2004). Of greater concern is chronic exposure to sub-lethal levels. Concerns over chronic exposure have led regulatory authorities in most countries to set safe limits of aflatoxin at 20 parts per billion (ppb) or less for human consumption; acute aflatoxin poisoning likely occurs at levels well over 1000 ppb.

Chronic exposure to aflatoxin has been associated in numerous studies with liver cancer in humans (Williams et al., 2004; Strosnider et al., 2006). Evidence also suggests that aflatoxin exposure may contribute to stunting in children, low birthweight, and suppressed immune response (Gong et al., 2004; Williams et al., 2004; Turner et al., 2007; Hoffmann et al., 2018; these effects have been demonstrated experimentally in a number of animal species (Williams et al., 2004).

2.2 The Kenyan context

Due to a combination of high maize consumption and high levels of contamination in maize in certain parts of the country, Kenya is one of the countries with the highest levels of aflatoxin exposure. Some of the most severe recorded outbreaks have been in Kenya, including one in 2004 during which at least 317 people were sickened and 125 died of acute aflatoxin poisoning (Azziz-Baumbartner et al., 2005). Natural variations in rainfall and seasonal storage requirements result in a high degree of variability in aflatoxin levels by year, region and season. The US Centers for Disease Control and Prevention tested samples of maize grain stored by farm households in eastern Kenya in 2005, 2006 and 2007 and found that 41, 51, and 16 percent of samples, respectively, exceeded 20 ppb (Daniel et al., 2011).

There is an official regulatory limit for allowable levels of aflatoxin in Kenya. The current standard, set by the Kenya Bureau of Standards, is 10 ppb. The standard was initially 20 ppb, which is also the current US standard, but this was later lowered because of the greater potential for chronic exposure due to the high level of maize consumption in Kenya (Daniel et al., 2011). However, enforcement of this standard in the formal sector is weak. Regulators do collect samples at both the mill and shop levels, but interviews with millers indicate that citations for violating the standard are rarely given.[1] Maize samples analyzed by researchers, however, show that flour frequently exceeds the allowable limit. In a 2013 study of branded flours, Hoffmann and Moser (2017) found that 26 percent of samples tested above the regulatory limit of 10 ppb. The same study showed large between-brand differences, with higher-priced brands less likely to exceed the standard.

Some mills do test for aflatoxin and reject lots that are contaminated above the allowable level. However, the high variability of aflatoxin contamination within a single load of maize means that even millers with the most stringent sampling and testing protocols may fail to meet the aflatoxin standard. However, at the time of this study, most millers' aflatoxin management practices were lacking on a variety of dimensions, including insufficient sampling of incoming grain, lack of final product testing, and the use of unverified test kits. Mills' costs of testing depends on both the number of tests performed per volume of maize and the technology used. Almost all mills test for moisture content, an important proxy for overall quality of stored grain. High moisture content at some point after harvest is necessary for fungal growth, and thus may be correlated with aflatoxin contamination, but this is not a reliable measure. Rapid binary tests for aflatoxins require little equipment and little expertise and, according to interviews with millers, cost approximately $11-$16 per 10 to 28 metric ton truckload of maize. More precise methods require several thousand dollars of upfront investment in test reading equipment with slightly lower costs ($6-$11) per test that are similar to the binary tests, though discounts of up to 100% on readers are available for larger orders (at least 500-2000 tests depending on the manufacturer).

Despite poor regulatory enforcement, there are several reasons why millers might invest in aflatoxin testing. First, recalls are occasionally issued by the Kenyan government when the level of aflatoxin detected in a given brand of flour is especially high. This can do irreparable damage to a brand's reputation. Second, the widespread availability of easy-to-use binary tests means that researchers, the media, or even private citizens can test maize flour. For example, writing in the Daily Nation, Gathura (2011) cites a study by the CDC and the Kenyan Ministry of Health finding that 65 percent of samples from 20 major millers across 6 provinces were contaminated. While this article did not name specific millers, there is little to prevent this from happening. Finally, millers might believe that stricter enforcement of the standard is imminent and they should prepare for that eventuality.

[1] None of three maize millers interviewed in 2013 indicated every having had a citation from the regulator for exceeding the allowable limit. 94 packets of maize meal from one of these millers were tested for aflatoxin by two of the authors for a previous study, and 27% were found to be contaminated beyond the allowable limit.

While some mills had been testing for aflatoxin at the time this study was initiated, there were no systems in place to validate or verify their sampling or testing protocols. Uncertainty about the legality of making food safety claims on product labeling, lack of confidence in their own test results, and fear of increased scrutiny were reported by millers as barriers to advertising aflatoxin testing practices. Without firm-specific information on food safety practices or outcomes, the average consumer in Kenya had no way to discern the likelihood that maize or maize flour they might purchase was contaminated.

Maize in Kenya can be categorized into three groups: subsistence maize for home consumption, informal market maize, and formal market (branded) maize flour. The informal market can be defined as the market for loose, whole grain maize sold in open-air markets and small shops throughout the country. Consumers take this maize to small, local hammer mills to be ground into flour. Increasingly, informal maize millers are also procuring maize grains themselves and selling flour to consumers. The market appears to be highly segmented; based on the nationally representative Household Consumption and Expenditure Survey (HCES) survey conducted in 2006, Fiedler et al. (2014) find that only 4 percent of consumers who purchased branded flour in a given week also purchased grains from the informal market; conversely, only 10 percent who purchased maize on the informal market also purchased branded flour.

The formal market consists of a small number of large roller mills that package flour in sealed paper packages indicating their brand name. The number of formal sector mills is in the low hundreds, with the three largest millers accounting for 67 percent of formal market sales (Juma and Wafula, 2011). According to Fiedler et al. (2014), in 2006 only 33 percent of households reported purchasing branded maize flour in the previous week even though 94 percent reported consuming maize. However, the formal sector maize market is growing in Kenya, particularly in urban areas (Muyanga et al., 2005).

Our study tests the impact of food safety claims on the market share of a formal sector maize miller in Kenya. Third party verification of the food safety practices of informal maize millers is not practicable due to their small scale, and the challenge of traceability limits the impact of testing further up the chain. There is, however, precedent in Kenya for enforcing regulations in the formal maize market. Since 2012, maize flour is required to be fortified with micronutrients. To facilitate compliance with this requirement, government and donors have worked to ensure that formal sector millers had the necessary equipment and training. According to Fiedler et al. (2014), it was determined that enforcing these standards at the level of the local hammer mills (i.e., the informal market) would be infeasible because of the high cost and monitoring difficulties.

3. STUDY DESIGN AND INTERVENTION

3.1 The APTECA program

Aflatoxin Proficiency Testing for Eastern and Central Africa (APTECA), was launched by Texas A&M AgriLife Research in 2014 to build the aflatoxin testing capacity of maize industry and regulatory bodies in the region. This initiative is patterned after a successful aflatoxin co-regulation program in Texas, where aflatoxin contamination of maize can be as severe as in Africa.[2]

In order to use the APTECA logo (see figure 1) on packaging or marketing materials, a miller must satisfy a number of requirements. Quality control staff must pass an aflatoxin analysis proficiency test; weekly analysis of laboratory control samples must be conducted to ensure testing accuracy; and the firm must develop and adhere to a rigorous aflatoxin food safety plan, which includes a sampling and testing procedure for inbound truckloads of maize and tests of each batch of finished product prior to packing. Audits of test records and related processes are performed weekly and companies that repeatedly test above the regulatory limit for aflatoxin must undertake corrective action and face a temporary suspension in use of the APTECA logo.

We partnered with Osho Grain Millers Ltd., the first commercial maize miller in Kenya to join the APTECA program and incorporate a label reading 'Aflatoxin tested - process verified by APTECA' on its packaging and marketing materials.[3] Because this was a costly and potentially low-return investment for Osho, the cost of compliance with APTECA requirements beyond the firm's current procedures during the study period were covered through the research budget, and APTECA membership was provided free of charge by Texas AgriLife Research.

3.2 Sales tracking

More than six months before introducing the APTECA label on its packaging, while Osho was working towards meeting program requirements, shops in six primarily rural counties in Eastern and Central Kenya that carried the firm's main product, Tupike maize flour,

[2] See http://apteca.tamu.edu/ for details on APTECA.
[3] At the time of writing, 13 Kenyan firms subscribe to APTECA's third party verification program.

were randomly selected from customer lists.[4] The selected counties, Embu, Kathiani, Kitui, Meru, Murgang'a, and Nyeri, are among the most aflatoxin-affected in Kenya.[5] If more than one shop in a given village or within walking distance of another sampled shop was selected, one of these was randomly selected for inclusion. Selected shops were visited and screened for eligibility based on the inclusion criterion of selling at least 48 kg of the miller's flour each week. Shops that did not meet this criterion were replaced with the next shop on the randomly ordered list located in the same village. If no such shop existed, the next shop on the list outside of the village served as the replacement.

After eligibility screening, a total of 98 shop owners were invited to participate in the study. Shop owners were told that if they chose to participate, they would be asked to track maize flour sales daily and provide this information to the study staff weekly; in compensation they would receive a payment of 2000 Kenyan shillings once every two weeks (approximately $22 US at the time).

Sales and prices of all maize flour brands were recorded by participating shop owners in a ledger provided to them. Enumerators collected sales tracking ledgers weekly, and reviewed entries with the owners before entering the data electronically on a tablet computer. In this way, shop owners were trained and retrained on how to correctly complete the sales sheets. The price of whole grain maize at a vendor near each participating shop was also recorded during data collection visits. Over the first two months of sales tracking, twenty of the initial 98 shops were dropped from the sample based on failure to consistently complete sales records, unwillingness to continue, or because their distance from other sampled shops in the county posed challenges to efficient data collection. Of the remaining 78 shops, five with much higher total maize flour sales than the rest were dropped from the sample to obtain a sample that was relatively homogenous.[6] In June 2015, the APTECA logo was added to the packaging of Tupike maize flour. At this time, each of the 73 study shops was randomly assigned to one of the following treatment groups after stratifying by county:[7]

C: Control (24 shops)

1M: One round of marketing, no discount (12 shops)

MM: Multiple marketing rounds, no discount (12 shops)

1D: One round of marketing with discount (12 shops)

MD: Multiple marketing rounds with discount (13 shops)

A poster advertising Tupike flour was displayed at all shops assigned to one of the four marketing treatments (1M, MM, 1D, MD) for the duration of the study. The poster highlighted the APTECA logo and the aflatoxin testing claim, and described aflatoxin and the health risks associated with exposure. In addition, field officers employed by the study engaged handed out leaflets to consumers at these shops and at the market nearest to each where unbranded maize flour or whole-grain maize was sold. Leafleting was conducted during week-long intervals according to a randomized marketing schedule. Figure 1 shows an image of the leaflet, which was similar to the poster, and which field officers were trained to explain in local languages.

The discount treatment consisted of a 5-shilling (0.05 USD) discount per kilogram, applied at each shop during one or more of the weeks when leafleting as also conducted. The discount, equivalent to approximately 10% of the product price, was intended to intensify the salience of the marketing campaign, and to induce consumers of cheaper brands, and perhaps some of those who normally consumed flour milled from whole maize grains, to switch – at least temporarily – to the promoted brand. In the multiple marketing group (MM), leafletting was repeated every four weeks for a total of three rounds. In the multiple discount group (MD), the discount and leafletting were repeated once, four weeks after the initial intervention, for a total of two rounds. A third intervention round in these shops, four weeks after the second discount week, consisted of leafletting only.[8]

---

[4] Fifteen shops per county were selected initially (approximately 9 months prior to the start of the intervention), and 11-14 of these were found to be eligible in each county. Due to concerns about heterogeneity in shop size, isolated or difficult to reach shops, and potential problems with data quality anticipated to lead to attrition, up to six additional shops per county were later added using the same procedure. The sample was finalized by six months prior to the start of the intervention.

[5] Nairobi is also an important market for Osho but was excluded from the study due to the greater mobility of urban consumers and anticipated challenges conducting surveys in an urban setting.

[6] Each of these shops had average weekly sales of maize flour 1265 kg or more per week; the next highest sales volume was 678 kg. These large volume shops often also served as wholesalers to smaller shops in outlying areas.

[7] Within-county stratification based on the average weekly sales of the miller's product was attempted but a coding error rendered the within-county strata meaningless. This second level of (failed) stratification is ignored in the analysis below; results in which dummies are included for these additional stratification cells are available from the authors and do not differ substantially from those presented here.

[8] A third round of discounting had been planned but was cancelled at Osho's request due to complaints from competing shops that stocked Tupike but were not offered the discount.

Once the miller began using packaging with the APTECA label, all shops stocked product with the label, but in shops assigned to the control group nothing was done to draw attention to the label, and Osho did not modify its general marketing efforts. The randomized social marketing intervention was thus the only way customers could learn about the significance of the APTECA logo. The marketing campaign was introduced over a four-week period, in a randomly determined order across shops within each treatment group and county. Thus, marketing was initiated in a quarter of the 1M, 1D, MM, and MD shops in each county during the first week, a quarter of shops in each treatment in the second week, and so on over the first four weeks of the intervention period.

3.3 Consumer surveys

Two surveys of consumers were conducted, a baseline in March 2015, survey prior to introduction of the APTECA label, and an endline survey in November 2015, approximately 22 weeks after introduction of the label and at least 13 weeks after the end of the randomized marketing campaign at each shop. During each survey round, consumers were recruited at two locations per shop: immediately outside of the study shop, and at the nearest location outside the shop where unbranded maize flour or bulk grains could be purchased. Recruitment was conducted at the second location to increase the likelihood that consumers whose primary source of maize was the informal market were also surveyed. Consumers were screened for eligibility to participate in the survey on the following criteria: age greater than 18 years, regular use of maize flour, and living within walking distance of the interview location. Through these surveys, information was collected on respondents' maize consumption practices, livelihoods, and demographic characteristics. The two surveys were similar but the endline included additional questions to assess consumers' recollection of the promoted brand, and their awareness of aflatoxin and the APTECA logo. On average, the baseline survey was administered to 25 consumers per study shop and the endline was administered to 17 consumers per shop, including those surveyed at the nearby informal market.

4. DESCRIPTIVE STATISTICS AND BALANCE TESTS

In this section we present data on maize sales and prices for the 73 study shops over 59 weeks from mid-October 2014 to late November 2015, as well as consumer characteristics at baseline. The intervention was rolled out in June 2015. Figure 2 shows the number of shops that completed a sales tracking form for each week of the study period, relative to the start of the intervention. Missing data is common in the first few months of the study, but from 8 weeks prior to the launch of the intervention in June 2015, at least 60 shops reported every week until the end of data collection 13 weeks after the end of the multiple-round marketing treatments (MM and MD). We observe a total of 3,466 shop-weeks when any flour was available for purchase. The study brand (Tupike) was available during 3,342 (96%) of shop-weeks.

During the study period, all shops carried at least one other brand in addition to Tupike; on average, shops stocked three other brands. The study brand was the lowest-price maize flour or tied for lowest-price in 88% of shop-week observations. In only 1.5% of cases was Tupike priced more than 5 KSH per KG above the next lowest priced flour. In contrast, the price of Tupike was higher than that of informally marketed maize grains plus the cost of milling in 90% of cases; in 78% of cases, Tupike was offered at 5 KSH or more above the price of flour on the informal market.

Stocking out of a particular brand was uncommon, but relatively more common for the study brand. Overall, a brand in stock on Monday was sold out by Sunday in only 2.3% of cases for which no delivery of that brand was taken during the week.[9] For Tupike, the rate of stock-outs was over double the average, at 5.1% of all shop-weeks. In the next section, we test whether the randomized marketing campaign affected sales of the study brand by increasing its availability rather than affecting consumer demand by looking at the impact of the treatments on the study brand stocks at the beginning of the week.

Pre-intervention sales and price variables at the shop level by treatment group are shown in Table A1. To test for balance in these variables across shops, each variable is regressed on treatment arm indicators, controlling for county fixed effects. Treatment assignment is balanced in terms of volume of sales of the study brand, as well as the prices of the study brand and other brands offered. However, total sales volume of non-study brands is significantly lower among shops assigned to the control group than in intervention group shops. In the analysis of sales data below, we utilize shop fixed effects, netting out any differences across treatment groups. In the analysis of endline consumer-level data, we control for the following pre-intervention variables, in addition to county fixed effects: log of mean weekly Tupike and total sales, pre-intervention mean Tupike price, and the mean price of all brands offered.

[9] Date of delivery was not recorded. It is possible that temporary stockouts could have occurred in shops that took deliveries as well.

Table A2 summarizes characteristics of the consumers interviewed during the baseline survey. Approximately 40% of respondents were male and 60% were female. The average respondent age was 36 years, and most reported making their living primarily through either microenterprise (36%) or farming (28%). 62% percent of households consisted of three to five members, with an average size of 4.4, and 49% contained a child under five years of age. A minority (36%) of households were connected to the electric grid, and 63% had either grown maize themselves over the past year or had received homegrown maize as a gift. Of the various categories of maize purchased by respondents, branded flour was the most common, with 81% of respondents reporting purchases over the past year. Purchase of kernels were next, at 39%, followed by unbranded flour at 33%. Just over half of respondents were interviewed outside the study shop itself, with the rest being interviewed at a nearby market. Respondent characteristics are generally similar across treatments, but of the 45 comparisons shown (of each treatment against the control group), seven are significantly different from zero at the 5% level. In order to control for these differences in consumer characteristics across treatments, we include shop-level means of the variables shown in Table A2 in the analysis of consumer knowledge and self-reported behavior at endline.

5. ANALYSIS AND RESULTS

5.1 Estimation strategy, sales tracking outcomes

We are interested in how food safety-based messaging affected Tupike sales during and after the randomized week-long marketing campaigns and accompanying temporary discounts. The key independent variables for this analysis, shown in Tables 1 and A3, are a set of time-varying indicators at the shop-week level, corresponding to weeks when the marketing campaign was active, either alone or combined with the temporary 5-KSh discount, and the periods following these campaigns. An indicator signifying the first active week of marketing without an accompanying discount (Marketing week 1) applies to shops in both the 1M and MM treatments. Likewise, the “Discount week 1” indicator applies to shops in both the 1M and MD treatments. However, “Marketing week 2” and “Marketing week 3” apply only to shops in the MM group; the second discount week and the final marketing week in the shops that had received two rounds of discount are analogously defined. In our primary specification, shown in Table 1, we define the post-marketing periods as three-week intervals. Thus, the first post-marketing interval (weeks 1-3 post-marketing week 1) in this table consists of the first, second, and third week after the first week of active marketing in treatment shops. For shops that received multiple weeks of the marketing interventions (MM and MD), only one post-intervention interval is defined after the first week of active marketing since after this, another round of marketing occurred. Similarly, only one post-intervention period is defined after the second round of active marketing (and discount), since after three weeks, the final round of active marketing was implemented. Appendix table Table A3 disaggregates the immediate post-marketing intervals into one-week segments, and Figure 3 illustrates the dynamic effect of marketing using coefficients from a similar specification. 10

The actual timing of each marketing week or post-marketing period differs across shops because the start date of the intervention was randomized over four weeks. This allows us to control in the regression for any common shock to demand in the region through the inclusion of week fixed effects from the week of intervention onset.11 In addition, we control for baseline differences across shops using with fixed effects.

5.2 Impact on Sales

Because the focus of our analysis is on consumer behavior, shop-weeks when Tupike was not available for purchase are omitted from the analysis of the promotion’s impact on Tupike sales. Likewise, shop-weeks when no other brands, or no maize flour at all, were available are omitted from the analysis of impact on sales of these. Since maize flour sales and inventories are highly skewed, we use a logarithmic transformation of these variables to reduce the influence of extreme values. This leads to the omission of 11 shop-week observations when maize flour was available but none was sold and 13 shop-weeks in which Tupike flour was available but none was sold. Standard errors are clustered at the shop level in all specifications.

The first column of Table 1 shows the impact of marketing and discount treatments on log sales of the study brand. During the first week of active marketing with no accompanying discount (M1 and MM) sales of the target brand were elevated by 22% above the baseline level.12 In the three-week period following active marketing, the magnitude of this effect drops by 50% and is statistically

---

[10] Later post-intervention periods remain as three-week intervals in the specification shown in A3 to preserve degrees of freedom. The figure includes additional post-intervention weeks after the final round of active marketing, and uses monthly instead of weekly dummies to preserve the necessary degrees of freedom required for this.

[11] To preserve degrees of freedom, we do not include time dummies prior to the start of marketing.

[12] Estimated percentage impacts are calculated by exponentiating the coefficients in regressions where the dependent variable is a log-transformed variable.

indistinguishable from zero. Turning to the disaggregated specification in A3 (column 1), there is some evidence of decay over time in the effect of marketing: in the first post-marketing week, the coefficient is 0.136 (not significant), whereas by the second week after active marketing the estimated effect is only 0.066.

Table 1. Impact of marketing and temporary discount on sales

Dependent variable		Log Tu-pike sales	Log Tu-pike stock	Log other brand sales	Log all sales
	Groups	(2)	(3)	(4)	(4)
Marketing only					
Marketing week 1	1M, MM	0.202**	0.298*	-0.215	0.015
		(0.098)	(0.168)	(0.142)	(0.083)
Weeks 1-3 post-marketing week 1	1M, MM	0.111	0.154	-0.056	-0.011
		(0.086)	(0.163)	(0.151)	(0.101)
Weeks 4-6 post-marketing week 1	1M	-0.118	0.127	0.134	-0.014
		(0.148)	(0.232)	(0.187)	(0.089)
Weeks 7-9 post-marketing week 1	1M	0.141	0.020	0.066	0.071
		(0.120)	(0.202)	(0.117)	(0.104)
Marketing week 2	MM	0.306*	-0.309	0.143	0.123
		(0.157)	(0.246)	(0.156)	(0.124)
Weeks 1-3 post-marketing week 2	MM	0.065	-0.137	0.014	-0.005
		(0.176)	(0.211)	(0.282)	(0.167)
Marketing week 3	MM	0.088	-0.163	-0.086	0.002
		(0.172)	(0.209)	(0.292)	(0.142)
Weeks 1-3 post-marketing week 3	MM	0.098	-0.381**	0.010	-0.012
		(0.119)	(0.167)	(0.228)	(0.147)
Weeks 4-6 post-marketing week 3	MM	0.059	-0.298*	-0.105	-0.072
		(0.158)	(0.158)	(0.205)	(0.143)
Weeks 7-9 post-marketing week 3	MM	-0.174	-0.308*	0.194	-0.120
		(0.195)	(0.179)	(0.227)	(0.197)
Marketing + temporary discount					
Discount week 1	1D, MD	1.316***	0.527**	-0.411	0.693***
		(0.205)	(0.232)	(0.258)	(0.148)
Weeks 1-3 post-discount week 1	1D, MD	0.436***	0.512***	0.041	0.127
		(0.137)	(0.155)	(0.156)	(0.100)
Weeks 4-6 post-discount week 1	1D	0.142	0.179	0.021	-0.091
		(0.192)	(0.160)	(0.269)	(0.211)
Weeks 7-9 post-discount week 1	1D	0.059	-0.136	0.118	-0.121
		(0.222)	(0.189)	(0.204)	(0.223)
Discount week 2	MD	1.104***	-0.029	-0.585*	0.556**
		(0.288)	(0.282)	(0.322)	(0.236)
Weeks 1-3 post-discount week 2	MD	0.393**	-0.216	-0.082	0.091
		(0.171)	(0.270)	(0.204)	(0.132)
Post-discount marketing week 3	MD	0.340	-0.180	-0.084	0.091
		(0.205)	(0.284)	(0.128)	(0.115)
Weeks 1-3 post-marketing week 3	MD	0.300*	-0.203	-0.186	0.011
		(0.168)	(0.249)	(0.178)	(0.125)
Weeks 4-6 post-marketing week 3	MD	0.239*	0.180	0.096	0.039
		(0.136)	(0.183)	(0.164)	(0.098)
Weeks 7-9 post-discount week 3	MD	-0.093	-0.189	-0.025	-0.173
		(0.160)	(0.207)	(0.145)	(0.135)
Observations		3,329	2,967	2,687	3,455
R-squared		0.065	0.025	0.051	0.054
Number of shops		73	73	73	73

Shop-level fixed effects are included. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The estimated effect of the second marketing push is slightly larger in magnitude at 36% (Tables 1 and 3A), though not statistically distinguishable from the first, and only significantly different from zero at the 10% level. The larger standard errors of this estimate can be ascribed to the fact that there are half as many shops in the MM treatment group as in the combined 1M and MM groups used to identify the effect of the first week of marketing. Again, the impact of marketing does not last beyond the week when flyers are being handed out. By the third week of active promotion, marketing alone has no perceptible impact on Tupike sales.

Turning to the effect of marketing combined with a temporary 5-KSH discount, we see a strong impact on sales during the discount: exponentiating the coefficient on the two discount weeks shows an increase in sales of approximately 2.7 times in the first week and approximately double in the second discount week. More interesting is the effect of the temporary discount in subsequent weeks. In the three weeks after the first time the discount is offered, Tupike sales remain 55% higher than in control shops; the three-week period after the second discount week shows a similar effect, with sales 48% higher. However, by four weeks post discount, the effect of the discount is fading. Despite the active marketing campaign during this week, sales of Tupike are not significantly higher than in control shops. The following two three-week periods show some evidence of elevated sales, at the 10% significance level, but by 7 weeks after the final discount week, the effect is gone. The week-by-week specification (Table A3) shows that the post-discount effects are not driven solely by the first or even second post-discount weeks. At three weeks after the discount is first offered, the impact is still significant at the 1% level. While effects after the second discount week are less statistically significant, the coefficients are similar to those observed after the first time the discount was offered. Again, this is attributable to the smaller number of shops where the discount was offered twice.

The increased sales of the study brand shown in column 1 of Tables 1 and A3 could be driven by current shop customers switching from other brands or by new customers drawn to the shop through the promotions. We explore this question by analyzing the impact of the intervention on log of total maize flour sales (Tables 1 and A3, column 2). Total sales were significantly affected by the promotion only during the weeks when a discount on Tupike flour was offered, though there is some evidence at the 10% significance level of elevated sales in the weeks following the first discount as well (Table A3). This suggests that the effect of marketing alone was primarily driven by existing customers switching from a competing brand of maize flour, but that the temporary discount did bring in new customers, some of whom continued to frequent the study shop.

5.3 Impact on Tupike inventory

In Column 3 of Tables 1 and A3, we present estimates of how the intervention affected Tupike inventory at the start of each week (or set of weeks, in the case of post-marketing intervals). We do this to test whether sales are driven by shop owners increasing their stock of Tupike in anticipation of the marketing campaign. Indeed, shop owners in all marketing and discount groups were warned by study staff ahead of the first week of active marketing that the brand would be promoted, and to ensure that they had some Tupike available. This was done to avoid frustration by both shop owners and customers in response to the observation that several shops in the treatment group did not have any Tupike in stock immediately prior to the initiation of marketing. We see shop owners' response reflected in the coefficients on both the first marketing and first discount weeks, as well as the first 3-week post-discount interval, and the first week after active marketing alone. The effect of marketing alone on sales faded by the first post-marketing week despite the fact that Tupike inventory was still elevated at this time, suggesting that inventory was neither the driver of the increase in sales, nor sufficient to keep sales elevated after active marketing ceased. The absence of any effect on Tupike stocks during the second discount week and the three subsequent weeks, but the presence of a strong effect on sales during this time also shows that inventory effects do not drive our results.

5.4 Impact on knowledge and awareness

The next set of estimations, shown in Table 2, uses consumer responses from the endline survey to assess the effect of treatment on consumers' awareness of the promoted brand, food safety labeling, and aflatoxin. Marginal effects estimated through probit regressions, with standard errors clustered at the shop level, are shown. Shop-level means of respondent characteristics described in Table A2, as well as the pre-intervention log of mean Tupike and total maize flour sales, and the mean price of Tupike and other brands in the study shop are included as controls. The same respondent characteristics, aside from maize purchasing behavior, of those interviewed at endline are also included.[13]

[13] As the composition of respondents could theoretically be influenced by treatment assignment, we present results from a specification omitting endline controls in Table A4. Results are very similar; the only difference is that in the version without respondent controls, we do not see significant impacts of any of the treatments on whether respondents had heard of aflatoxin.

Almost 5 months after the end of marketing in shops where a single week of intensive marketing was conducted, and 3 months after the cessation of all active marketing, many consumers still recalled the promoted brand. At one-time marketing only shops, consumers were 23 percentage points (pp) more likely to name Tupike as the subject of a promotion during the past 6 months than at control shops, where 8% recalled a Tupike promotion. Multiple rounds of promotion (with or without the discount) did not significantly affect recollection of the promoted brand relative to one-time marketing. The temporary discount, on the other hand, had a strong effect on consumers' recollection of the promoted brand within both the one-week and the multiple-week treatments, increasing this by 14 and 15 percentage points respectively.

Table 2. Impact on consumer awareness of promotion and aflatoxin at endline

	Names study brand as promoted	Names study brand as tested for aflatoxin	Can identify APTECA logo	Heard of aflatoxin	Identifies link between cancer and aflatoxin
Single marketing only (1M)	0.227***	0.079***	0.103	0.053	0.072***
	(0.039)	(0.029)	(0.088)	(0.043)	(0.022)
Multiple marketing only (MM)	0.278***	0.221***	0.034	0.084**	0.043*
	(0.039)	(0.037)	(0.066)	(0.033)	(0.022)
Single marketing + discount (1D)	0.368***	0.132***	0.010	0.049	0.055***
	(0.038)	(0.039)	(0.063)	(0.032)	(0.021)
Multiple marketing + discount (MD)	0.430***	0.152***	0.041	0.076**	0.051***
	(0.042)	(0.039)	(0.070)	(0.035)	(0.018)
Tests across treatments					
1M vs. MM	0.313	0.000	0.465	0.428	0.325
1D vs. MD	0.195	0.645	0.673	0.288	0.840
1M vs. 1D	0.008	0.101	0.292	0.913	0.549
MM vs. MD	0.002	0.119	0.937	0.801	0.773
Observations	1,225	1,225	1,225	1,225	1,225
Clusters	72	72	72	72	72
Mean, Control Group	0.081	0.075	0.240	0.762	0.036

Notes: Shown are marginal effects of each treatment on the probability of a positive outcome, as estimated through a probit regression, with cluster-robust (shop-level) standard errors in parentheses. County fixed effects, location of interview (informal market vs. sample shop), log of pre-intervention weekly Tupike and total maize flour sales, pre-intervention mean price of other maize flour brands, baseline shop-level means of respondent characteristics shown in Table A2, and the same contemporaneous respondent characteristics except for those related to maize purchases are included as controls. *** p<0.01, ** p<0.05, * p<0.1

The one-week marketing only intervention approximately doubled consumers' awareness that Tupike flour is tested for aflatoxin relative to the control group, 7.5% of whom were aware of this. Multiple weeks of marketing alone, which also implied more recent exposure to the campaign (13 weeks vs. 21 weeks prior to the endline survey) had a much stronger effect on this outcome, increasing awareness by 19 pp. The effect of the temporary discount on awareness of the brand's aflatoxin testing claim is similar to that of marketing, and consumer awareness is not significantly affected by multiple rounds of the discount, suggesting that in a promotion focused on price, claims about food safety may be less salient to consumers.

When shown four logos and asked to select the one indicating that flour has been tested for aflatoxin, consumers at control shops correctly identified the APTECA about one quarter of the time, as would be expected under purely random choice.[14] None of the treatments significantly affected consumers' ability to identify the logo.

Basic awareness of aflatoxin was high even at control shops, where 76% of respondents claimed to have heard of the toxin. Marketing over multiple rounds, with or without the discount, increased the proportion of consumers who said they had heard of aflatoxin by

[14] In addition to the APTECA logo shown on Tupike packaging and associated marketing materials, respondents were shown a draft APTECA logo, the Kenya Bureau of Standards logo (present on all packaged food items), and the Ministry of Health's logo indicating micronutrient fortification.

approximately 8 pp. The point estimate of this effect at single-round marketing shops was approximately 5 pp but not distinguishable statistically either from the level at control shops, or from the effect of multiple rounds of marketing. Each of the marketing treatment arms increased consumer knowledge of the link between aflatoxin and cancer, the most specific health consequence of exposure mentioned in the marketing campaign. Knowledge that aflatoxin causes cancer was very low in the absence of the intervention, with fewer than 4% of consumers making this connection. Despite consumers' stronger recollection of the study brand at shops where the discount was offered compared to shops where only marketing was conducted without the discount, we do not observe a differential effect of the discount treatment on either the brand's food safety claim, or on more general knowledge about aflatoxin.

5.5 Impact on knowledge and awareness

Since the marketing intervention affected Tupike sales, we expect that it should have increased the proportion of consumers who had tried Tupike by the time of the endline survey. This could affect perceptions of the brand either positively or negatively, depending on the quality of consumers' experience compared to their priors. In Table 3, we assess the impact of the randomized promotion on consumer experience with and perceptions of Tupike, using the same probit specification to generate results shown in Table 2.[15] Indeed, as shown in the first column of Table 3, at all treatment shops except those assigned to the one-time marketing only treatment (1M), consumers were significantly more likely to report having tried Tupike than those interviewed at control shops. Subsequent columns show the impact of the campaign on perceptions of the brand; perceptions variables are equal to 1 if consumers assessed Tupike as "good" or "very good" on a particular dimension, and 0 otherwise (including those who have never tried the brand).

Table 3. Impact on consumer experience and perceptions of Tupike

		Favorable rating of Tupike's:				
	Has tried Tupike	Taste	Texture	Cooking time	Overall quality	Tupike is usual brand
Single marketing only (1M)	-0.014	0.039	-0.037*	-0.042	-0.016	-0.029
	(0.055)	(0.056)	(0.020)	(0.056)	(0.052)	(0.077)
Multiple marketing only (MM)	0.189***	0.187***	-0.050***	0.174***	0.156***	0.139***
	(0.030)	(0.047)	(0.019)	(0.040)	(0.044)	(0.044)
Single marketing + discount (1D)	0.183***	0.162***	-0.047***	0.165***	0.152***	0.182***
	(0.034)	(0.045)	(0.017)	(0.042)	(0.037)	(0.048)
Multiple marketing + discount (MD)	0.163***	0.172***	-0.040**	0.148***	0.114**	0.182***
	(0.042)	(0.047)	(0.019)	(0.045)	(0.049)	(0.065)
Tests across treatments						
1M vs. MM	0.000	0.016	0.375	0.000	0.001	0.028
1D vs. MD	0.602	0.834	0.645	0.718	0.451	0.994
1M vs. 1D	0.000	0.0291	0.498	0.000	0.001	0.009
MM vs. MD	0.500	0.752	0.518	0.565	0.432	0.508
Observations	1,225	1,225	1,225	1,225	1,225	1,225
Clusters	72	72	72	72	72	72
Mean, Control Group	0.695	0.613	0.0679	0.604	0.579	0.365

Notes: Shown are marginal effects of each treatment on the probability of a positive outcome, as estimated through a probit regression, with cluster-robust (shop-level) standard errors in parentheses. County fixed effects, location of interview (informal market vs. sample shop), log of pre-intervention weekly Tupike and total maize flour sales, pre-intervention mean price of other maize flour brands, baseline shop-level means of respondent characteristics shown in Table A2, and the same contemporaneous respondent characteristics except for those related to maize purchases are included as controls. *** p<0.01, ** p<0.05, * p<0.1

In general, consumers in control shops assessed Tupike as having good or very good taste (61% favorable ratings), but poor texture (7% favorable). The intervention strengthened these perceptions, increasing the proportion of consumers who gave a favorable report of Tupike's taste, and decreasing the proportion who rated the texture favorably. Assessments of the brand's cooking time and overall quality were also higher in treatments for which the intervention increased proportion of consumers who had tried it. Effects on consumer experience outcomes are similar for the MM, 1D, and MD treatments.

[15] As for Table 2, we present results from a specification omitting endline controls in the appendix (Table A5).

5.6 Substitution from other maize types

The public health consequences of food safety labeling depend not only on which foods consumers consumer more of, but also on which foods they consume less of. In Table 4, we show treatment impacts on the likelihood that consumers reported purchasing more, the same, or less, of four categories of maize flour over the past six months: the promoted brand, branded flour in general, unbranded flour, and whole maize grains purchased for the purpose of milling. To increase power for this analysis, and because we expect that the effects on switching behavior may differ between the marketing only and marketing plus discount and interventions but are unlikely to differ between the single and multiple marketing rounds, we combine the two marketing only treatment groups (1M and MM) and the two discount treatment groups (1D and MD) in this analysis. We see that consumers exposed to both the marketing only and discount treatments shifted away from unbranded flour. In addition, those exposed to marketing only were somewhat more likely to increase their consumption of branded flour generally. We see no impact of the interventions on purchases of whole grains for grinding.

Table 4. Reported changes in maize purchases, past six months

Ordered probit results -1=decrease 0=no change 1= increase	(1) Study brand	(2) All branded flours	(3) Unbranded flour	(4) Whole grains for grinding
Marketing (1M, MM)				
Decrease	-0.056***	-0.035*	0.045**	0.005
	(0.013)	(0.020)	(0.018)	(0.023)
No change	-0.054***	-0.035*	-0.011*	-0.002
	(0.016)	(0.021)	(0.007)	(0.007)
Increase	0.11***	0.07*	-0.034***	-0.004
	(0.024)	(0.041)	(0.013)	(0.016)
Discount (1D, MD)				
Decrease	-0.05***	-0.03	0.04**	0.015
	(0.016)	(0.020)	(0.017)	(0.025)
No change	-0.038**	-0.028	-0.009*	-0.005
	(0.017)	(0.019)	(0.005)	(0.009)
Increase	0.088***	0.058	-0.031**	-0.01
	(0.031)	(0.039)	(0.013)	(0.016)
Observations	1225	1225	1225	1225
Clusters	72	72	72	72
Proportion of respondents in control areas who report:				
Decrease	0.041	0.143	0.109	0.129
No change	0.880	0.473	0.785	0.854
Increase	0.079	0.385	0.106	0.066

Notes: Shown are marginal effects of each treatment on the probability of reporting a decrease, no change, or increase in consumption for each type of maize, as estimated through an ordered probit regression, with cluster-robust (shop-level) standard errors in parentheses. County fixed effects, location of interview (informal market vs. sample shop), log of pre-intervention weekly Tupike and total maize flour sales, pre-intervention mean price of other maize flour brands, baseline shop-level means of respondent characteristics shown in Table A2, and the same contemporaneous respondent characteristics except for those related to maize purchases are included as controls. *** p<0.01, ** p<0.05, * p<0.1

6. DISCUSSION

In this section, we review the primary study findings and discuss potential mechanisms behind them. The first result is that promotion based on food safety has a significant, but short-lived, effect on sales. The impact of marketing alone on sales does not last beyond the period during which an intensive, in-person marketing campaign is active. By the third time such a campaign is implemented at a shop, it has no discernable effect on sales at all. The second result is that adding a temporary discount to the marketing campaign increased the impact of the promotion on sales of the promoted brand for several weeks after the discount was no longer offered. The results raise two questions. First, why does the effect of marketing fade over time? Second, why does the effect of the discount persist beyond the period during which it was offered, while that of marketing alone faded immediately?

Were consumers who tried the brand disappointed with it? If so, this could explain the immediate decay of the sales effect observed under the marketing treatment, but not the slower decay when the discount was also offered. Further, results on consumers' subjective assessments of Tupike suggest disappointment is not the mechanism behind the fading impact of the marketing intervention. As shown in Table 3, the experimental treatments that increased the proportion of consumers interviewed at endline who had tried Tupike also increased the proportion of consumers who rated its overall quality favorably. Since consumer ratings may be subject to experimenter demand effects, we also conducted a blind taste test during the endline survey with a subset of 640 respondents.[16] Respondents were asked to rate the overall quality of each of three samples of stiff porridge cooked from three different maize flours offered by the study shop or in the local market. Tupike was ranked first of three brands offered approximately 40% of the time and third only 26% of the time—differences that differ significantly from what would be expected under random choice. This result provides additional confidence that consumers' experience with Tupike catalyzed by the promotion improved their impression of the brand.

Is consumers' fading recollection of the marketing intervention over time, together with its relatively modest impact, behind the short-lived result of this treatment? This may be some of the explanation, but not all: 21 weeks after the single week of marketing at 1M shops, 31% of consumers were able to name the study brand, compared to 8% of those at control shops. The proportion of consumers who recalled the study brand at shops where marketing had ended just 13 weeks prior to the endline survey was not significantly higher than at 1M shops. Repetition of the marketing campaign did seem to effect customers' recollection of its specifics at endline: consumers at MM shops are nearly three times as likely to recall that Tupike is tested for aflatoxin as those at 1M shops. This could be due to multiple points of contact with the campaign having more impact on this point of information than a single interaction, or to fading recollection of the campaign's details. If the latter, the implied rate of decay in knowledge, over an 8-week period, is modest: assuming a linear trend, the proportion of consumers who named Tupike as tested for aflatoxin fell by 1.78 pp per week, less than 5% of the projected initial level at the time of the promotion (still assuming this linear trend). The impact of marketing on Tupike sales, on the other hand, calculated based on exponentiated coefficients shown in column 1 of Table A3, was already a third lower one week after active marketing, and by 69% lower two weeks later, compared to when marketing was active. We conclude that decaying knowledge is not behind decaying effect of promotion on sales.

Our preferred explanation for the short-lived impact of marketing on sales is that the promotion temporarily brought the study brand, and aflatoxin to the top of consumers' minds. The salience of food safety as a factor in brand choice faded rapidly, as other considerations or pre-existing purchasing habits eclipsed the message of the marketing campaign.

Turning to the effect of the discount treatment, one potential explanation could be that consumers were confused about the temporary nature of the discount. Given that our discount treatment was clearly advertised as being for "this week only" and given that other brands were available most weeks in each study shop, we do not believe the increased sales resulted from customers returning in subsequent weeks hoping for a discount. Field staff were careful not to alert consumers and shop owners in the multiple discount shops that the promotion would be repeated.

A similar shift of consumers' attention toward the study brand as that proposed above to explain the marketing effect, though one less focused on food safety, could also explain the longer-lasting impact of the limited-time discount. The discount resulted in many consumers switching from other brands, or unbranded flour to Tupike. After the discount ended, many consumers at these shops continued to identify Tupike as their preferred, or perhaps simply their default, brand – an effect that could be characterized as brand

[16] The study brand plus two other brands available at that shop or locally were cooked into *ugali* and offered to a subsample of consumers interviewed at endline. The two other brands offered differed by shop. The order of the samples offered to consumers was randomized and consumers were asked to rank the samples.

loyalty. However, as in the marketing treatment, other factors – perhaps a stock-out of Tupike, perhaps availability of a lower-priced brand or shortage of cash – eventually eroded the effect of the intervention on Tupike sales.

We note that while temporary discount was effective at capturing consumers' attention, it was less effective at building consumer awareness of the brand's food safety claim. The relatively durable effect of the temporary discount thus does not appear related to stem from greater awareness of the food safety claim in consumers exposed to this treatment. Nor does the impact appear to be driven by an effect on the credibility of the food safety claim, which is uniform across treatments.

Despite the apparent lack of a food safety motivation among these consumers who continued to purchase Tupike at shops where a discount had been offered, the effect of the did likely improve the safety of the food they consumed. As shown in Table 4, consumers who switched to the promoted brand mostly shifted away from pre-milled but unbranded maize flour. Unbranded flour is likely to be the most aflatoxin-contaminated of the maize categories considered, as its quality (in terms of discolored or broken kernels) is far less observable than that of whole kernels, and companies offering branded maize have incentives to invest in quality and safety (Hoffmann and Moser, 2017).

Implications of these results for the profitability of food safety marketing depend on the nature of competition faced within a particular market and by a particular firm. The firm with which we collaborated competes primarily on price and earns margins far thinner than the temporary discount made possible through the study budget. Marketing based on a food safety claim was not an effective strategy for this firm. To the extent that this situation is typical of firms serving mass markets in low-income settings, it is unrealistic to expect for-profit firms to invest heavily in marketing based on food safety claims. There remains an important role for the public sector in promoting consumer awareness of and demand for food safety, and in creating conditions in which firms find it profitable to invest in making their products safer. In settings where enforcement of standards is not feasible due to dominance of the informal sector or capacity constraints, food safety improvements could still be achieved by building firm capability and providing incentives for firms to comply with standards. Our results suggest that expecting these incentives to originate from consumer demand for food safety, especially at the lower end of the market, is not realistic. An alternative policy approach could be to offer tax relief to firms that perform well in terms of food safety.

REFERENCES

Azziz-Baumgartner E, Lindblade K, Gieseker K, Rogers HS, Kieszak S, Njapau H, et al. 2005. Case–control study of an acute aflatoxicosis outbreak in Kenya. Environ Health Perspectives 113:1779–1783.

Banerjee, A.V. and Mullainathan, S., 2008. Limited attention and income distribution. The American Economic Review, 98(2), pp.489-493.

Birol, E., Karandikar, B., Roy, D. and Torero, M., 2015. Information, Certification and Demand for Food Safety: Evidence from an In-store Experiment in Mumbai. Journal of Agricultural Economics, 66(2), pp.470-491.Bordalo, P., Gennaioli, N. and Shleifer, A., 2013. Salience and consumer choice. Journal of Political Economy, 121(5), pp.803-843.

Brown, J. D. 1969. Effect of a health hazard "scare" on consumer demand. American Journal of Agricultural Economics, 51(3), 676-678.

Burton, M. and Young, T., 1997. Measuring meat consumers' response to the perceived risks of BSE in Great Britain, Risk Decision and Policy, 2(1), pp. 9-18.

Burton M, Young T, and Cromb R. 1999. Meat consumers' long-term response to perceived risks associated with BSE in Great Britain. Economics and Sociology Rural Studies, 50, 7–19.

Daniel, J. H., L. W. Lewis, Y. A. Redwood, S. Kieszak, R. F. Breiman, W. D. Flanders, C. Bell, J. Mwihia, G. Ogana, S. Likimani, M. Straetemans, and M.A. McGeehin. 2011. "Comprehensive Assessment of Maize Aflatoxin Levels in Eastern Kenya, 2005–2007." Environmental Health Perspectives 119 (12): 1794–1799.

Dupas, P., 2011. Health behavior in developing countries. Annu. Rev. Econ., 3(1), pp.425-449

Fiedler, J. L., Afidra, R., Mugambi, G., Tehinse, J., Kabaghe, G., Zulu, R., Lividini, K., Smitz, M.-F., Jallier, V., Guyondet, C. and Bermudez, O. 2014. Maize flour fortification in Africa: markets, feasibility, coverage, and costs. Annals of the New York Academy of Sciences, 1312: 26–39. doi: 10.1111/nyas.12266

Gathura, G. 2011. "Study Finds 65 p.c. of Flour Unfit for Eating." Daily Nation. March 16. Accessed February 15, 2013, at http://www.nation.co.ke/News/Study+finds+65+pc+of+flour+unfit+for+eating+/-/1056/1127586/-/amo111z/-/.

Gong, Y., A. Hounsa, S. Egal, C.P. Turner, A.E. Sutcliffe, A.J. Hall, K. Cardwell, and C.P. Wild. 2004. Postweaning exposure to aflatoxin results in impaired child growth: a longitudinal study in Benin, West Africa. Environmental Health Perspectives, 112 (13): 1334-1338.

Gnonlonfin, G. J. B., Y. C. Adjovi, A. F. Tokpo, E. D. Agbekponou, Y. Ameyapoh, C. de Souza, L. Brimer, and A. Sanni. 2013. "Mycobiota and Identification of Aflatoxin Gene Cluster in Marketed Spices in West Africa." Food Control 34 (1): 115–120.

Hoffmann, V., and K. M. Gatobu. 2014. "Growing Their Own: Unobservable Quality and the Value of Self-Provisioning." Journal of Development Economics 106: 168–178.

Hoffmann V, Jones K, Leroy JL The impact of reducing dietary aflatoxin exposure on child linear growth: a cluster randomised controlled trial in Kenya BMJ Global Health 2018;3:e000983.

Hoffmann, Vivian, and Christine Moser. "You get what you pay for: the link between price and food safety in Kenya." Agricultural Economics (2017).

Ifft, J., Roland-Holst, D. and Zilberman, D., 2012. Consumer valuation of safety-labeled free-range chicken: results of a field experiment in Hanoi. Agricultural Economics, 43(6), pp.607-620.

Johnson, F. R. 1988. Economic costs of misinforming about risk: the EDB scare and the media. Risk Analysis, 8(2), 261-269.

Juma, V. and P. Wafula, 2011. Top millers under probe over high prices of maize flour." Business Daily. May 5. Accessed April 24, 2015, at http://www.businessdailyafrica.com/Corporate-News/Top-millers-under-probe-over-high-pricing-of-maize-flour/-/539550/1156508/-/11ggbb2/-/index.html.

Kahneman, D. and Tversky, A., 1984. Choices, values, and frames. American psychologist, 39(4), p.341.Khlangwiset, P., G. S. Shephard, and F. Wu. 2011. "Aflatoxins and Growth Impairment: A Review." Critical Reviews in Toxicology 41 (9): 740–755.

Kirimi, L., N. Sitko, T. S. Jayne, F. Karin, M. Muyanga, M. Sheahan, J. Flock, and G. Bor. 2011. A Farmgate-to-Consumer Value Chain Analysis of Kenya's Maize Marketing System. Working paper WPS 44/2011. Tegemeo Institute of Agricultural Policy and Development. Nairobi, Kenya.

Kremer, M. and Glennerster, R., 2011. Improving Health in Developing Countries. Handbook of Health Economics, 2, pp.201-315.

Muyanga, M., T.S. Jayne, G. Argwings-Kodhek, and Joshua Ariga. 2005. Staple Food Consumption

Patterns in Urban Kenya: Trends and Policy Implications. Tegemeo Working Paper No. 16. Tegemeo Institute of Agricultural Policy and Development, Egerton University.

Ortega, D.L. and Tschirley, D.L., 2017. Demand for food safety in emerging and developing countries: A research agenda for Asia and Sub-Saharan Africa. Journal of Agribusiness in Developing and Emerging Economies, 7(1), pp.21-34.

Oster, E., 2017. Diabetes and Diet: Purchasing Behavior Change in Response to Health Information. American Economic Journal: Applied Economics.

Piggott, N. E., & Marsh, T. L. 2004. Does food safety information impact US meat demand? American Journal of Agricultural Economics, 86(1), 154-174.

Rothman, A.J. and Salovey, P., 1997. Shaping perceptions to motivate healthy behavior: the role of message framing. Psychological bulletin, 121(1), p.3.

Spears, D., 2014. Decision costs and price sensitivity: Field experimental evidence from India. Journal of Economic Behavior & Organization, 97, pp.169-184.

Strosnider, H., E. Azziz-Baumgartner, M. Banziger, R. V. Bhat, R. Breiman, M.-N. Brune, K. DeCock, A. Dilley, J. Groopman, K. Hell, S.H. Henry, D. Jeffers, C. Jolly, P. Jolly, G.N. Kibata, L. Lewis, X. Liu, G. Luber, L. McCoy, P. Mensah, M. Miraglia, A. Misore, H. Njapau, C. Ong, M.T.K. Onsongo, S.W. Page, D. Park, M. Patel, T. Phillips, M. Pineiro, J. Pronczuk, H. Schurz Rogers, C. Rubin, M. Sabino, A. Schaafsma, G. Shephard, J. Stroka, C. Wild, J.T. Williams, and D. Wilson. "Workgroup Report: Public Health Strategies for Reducing Aflatoxin Exposure in Developing Countries." Environmental Health Perspectives 114 (12): 1898–1903.

Turner, P. C., Collinson, A. C., Cheung, Y. B., Gong, Y., Hall, A. J., Prentice, A. M., & Wild, C. P. 2007. Aflatoxin exposure in utero causes growth faltering in Gambian infants. International Journal of Epidemiology, 36(5), 1119-1125.

Williams, Jonathan H., Timothy D. Phillips, Pauline E. Jolly, Jonathan K. Stiles, Curtis M. Jolly, and Deepak Aggarwa. (2004. "Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions." The American journal of clinical nutrition 80, no. 5: 1106-1122.

World Health Organization. 2015. “WHO estimates of the global burden of foodborne diseases: foodborne disease burden epidemiology reference group 2007-2015.” ISBN 978 92 4 15651.

APPENDIX: FIGURES AND ADDITIONAL TABLES

Figure 1. Promotional leaflet with APTECA logo

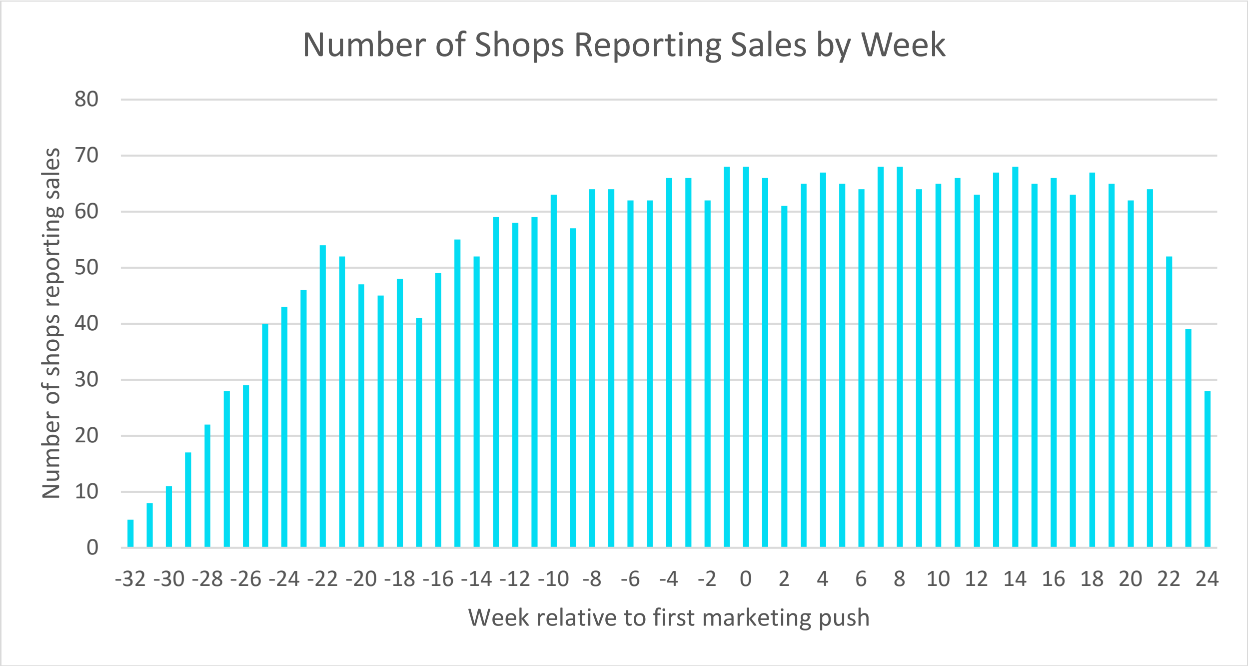

Figure 2. Number of study shops reporting sales by week

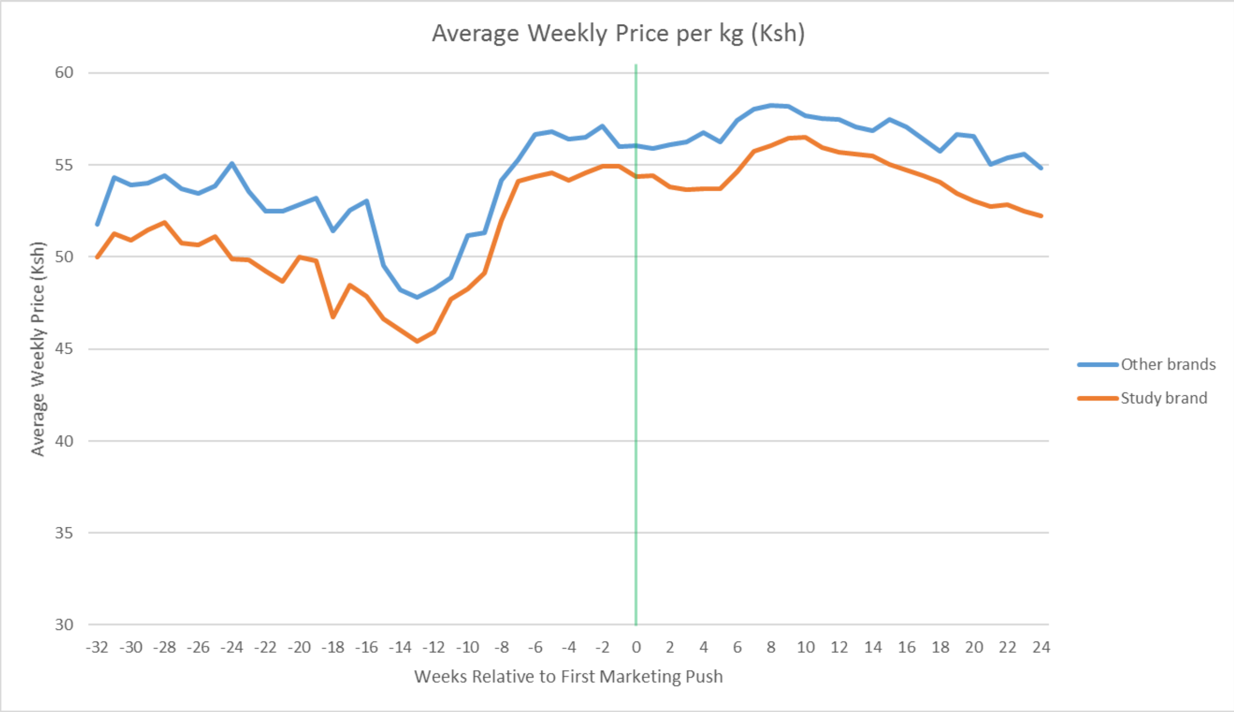

Figure 3. Average weekly price in Kenyan Shillings for study brand and other brands in study shops

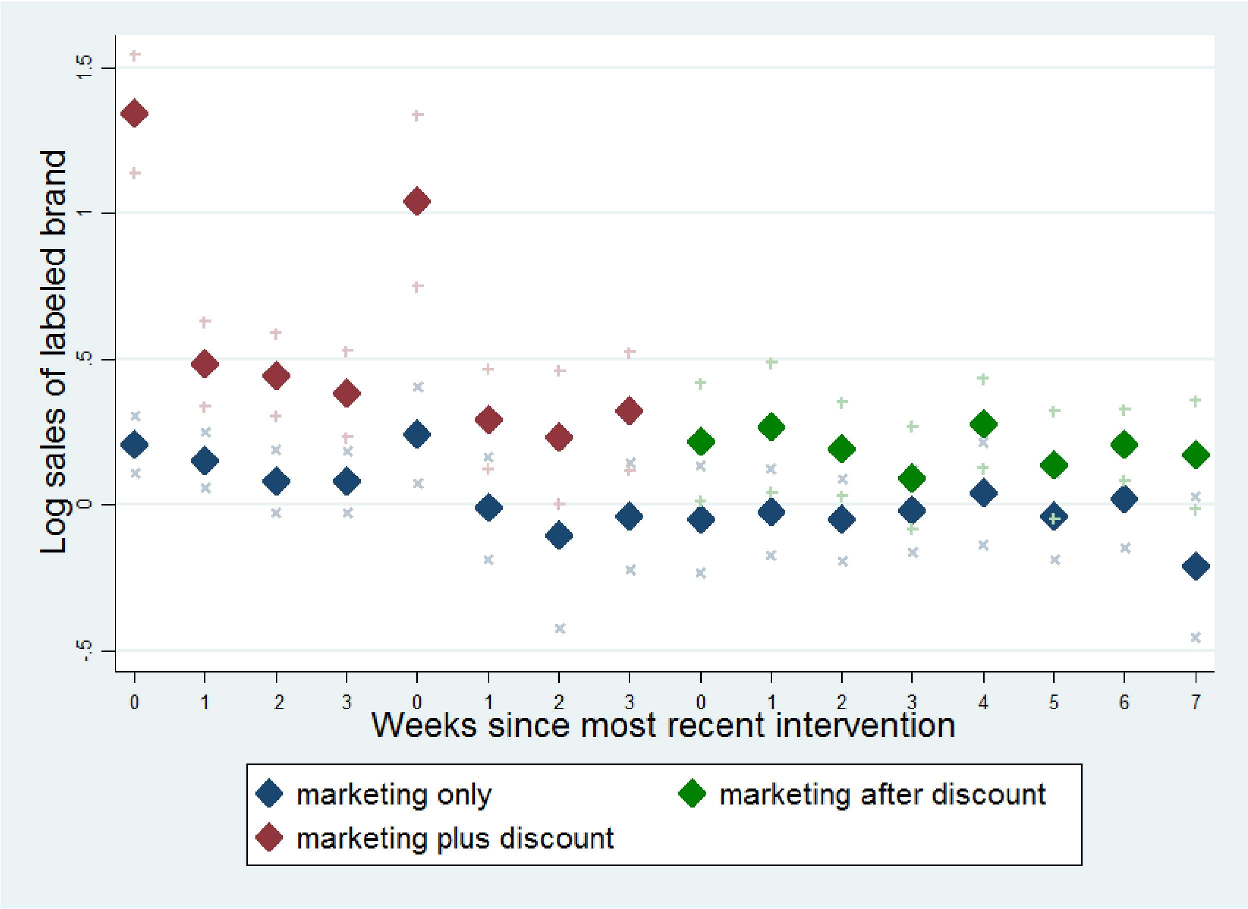

Figure 4. Estimation results of the effect of treatment on sales in subsequent weeks. Based on a regression similar to that shown in column 1, table A2, with additional weekly lags after the final intervention, and monthly instead of weekly controls.

Table A1. Summary statistics at baseline and balance check, key sales variables

	Tupike sales (KG)	Tupike sales (log KG)	Tupike price	Total sales (KG)	Total sales (log KG)	Other brands mean price	Informal flour price / KG	N
Control	120	4.35	51.1	410	5.34	53.1	42.8	24
	(146)	(0.89)	(3.07)	(498)	(1.21)	(6.5)	(6.1)	
1M	106	4.41	51.0	606	5.88	54.9	43.0	12
	(90)	(0.71)	(2.55)	(587)	(1.13)	(4.3)	(6)	
MM	120	4.38	50.6	718	6.1*	54.1	44.5	12
	(101)	(1)	(2.7)	(593)	(1.13)	(5.1)	(6)	
1D	103	4.26	50.5	722	6.14**	56.7**	44.8	12
	(88)	(0.94)	(3.24)	(737)	(0.98)	(6.3)	(7.1)	
MD	81	4.22	50.6	845**	6.04*	54.5	42.3	13
	(46)	(0.63)	(3.4)	(957)	(1.4)	(6.5)	(4.7)	
Total	108	4.33	50.8	622	5.81	54.4	43.4	73
	(107)	(0.83)	(2.95)	(669)	(1.2)	(5.9)	(5.9)	

Notes: Shop-level means and standard deviations (in parentheses) before the start of the intervention are shown. Statistically significant differences from the control group based on regressions of each variable on treatment indicators. * p<0.1; ** p<0.05; *** p<0.01. The maximum number of observations per variable is shown in the final column; log of non-study brand sales, and mean price of non-study brands are missing for one of the control treatment shops as this shop sold no other brands prior to the intervention.

Table A2. Summary statistics and balance check, consumer characteristics at baseline

	Control	1M One time marketing, no discount	MM Multiple marketing, no discount	1D One time marketing and discount	MD Multiple marketing and discount
Male	0.45	0.37	0.36*	0.34**	0.42
Age	35.7	34.6	36.7	36.7	37.55*
Completed secondary school	0.39	0.37	0.41	0.34	0.35
Microenterprise	0.37	0.28*	0.43*	0.33	0.40
Farmer	0.26	0.28	0.21	0.36*	0.28
Casual laborer	0.15	0.18	0.16	0.13	0.13
Salaried employee	0.12	0.14	0.11	0.08	0.09
Number of household members	4.31	4.44	4.33	4.52	4.43***
Lives with children under 5	0.47	0.53**	0.52	0.48	0.49
Household has electricity	0.33	0.41	0.46**	0.32	0.34
Grew or received homegrown maize	0.60	0.67**	0.63	0.64	0.61*
Bought maize grain past year	0.38	0.40	0.41	0.40	0.38
Bought unbranded flour past year	0.34	0.30	0.35	0.34	0.31
Bought branded flour past year	0.84	0.76**	0.83	0.76*	0.79***
Surveyed at informal market	0.45	0.5*	0.5*	0.49	0.52**
Sample size	652	282	287	306	326

Notes: Means for consumers interviewed at each study shop and nearby informal maize market, by shop treatment assignment, are shown. Asterisks indicate significance of differences in means between respondents interviewed at or near shops in each treatment group and those interviewed at or near control group shops, based on regressions of each variable on treatment indicators and county fixed effects. *** p<0.01, ** p<0.05, * p<0.1.

Table A3. Impact of marketing and temporary discount on sales (weekly post-intervention dummies)

Dependent variable		Log Tupike sales	Log Tupike stock	Log all sales
	Groups	(1)	(2)	(3)
Marketing only				
Marketing week 1	1M, MM	0.198**	0.309*	0.011
		-0.097	-0.168	-0.082
Week 1 post-marketing week 1	1M, MM	0.136	0.437***	-0.031
		-0.09	-0.164	-0.094
Week 2 post-marketing week 1	1M, MM	0.066	-0.018	-0.029
		-0.107	-0.239	-0.122
Week 3 post-marketing week 1	1M, MM	0.091	0.023	0.016
		-0.094	-0.211	-0.1
Weeks 4-6 post-marketing week 1	1M	-0.148	0.108	-0.016
		-0.142	-0.216	-0.085
Marketing week 2	1M, MM	0.286*	-0.328	0.124
		-0.157	-0.248	-0.123
Week 1 post-marketing week 1	MM	0.037	-0.044	-0.076
		-0.176	-0.261	-0.175
Week 2 post-marketing week 1	MM	-0.009	-0.087	0.061
		-0.3	-0.34	-0.153
Week 3 post-marketing week 1	MM	0.081	-0.288	0.029

		-0.194	-0.299	-0.19
Marketing week 3	MM	0.059	-0.144	0.016
		-0.17	-0.203	-0.141
Week 1 post-marketing week 1	MM	0.104	-0.389	0.052
		-0.143	-0.261	-0.121
Week 2 post-marketing week 1	MM	0.066	-0.518*	0.028
		-0.147	-0.269	-0.171
Week 3 post-marketing week 1	MM	0.076	-0.192	-0.084
		-0.135	-0.18	-0.166
Weeks 4-6 post-marketing week 3	MM	0.054	-0.299*	-0.074
		-0.159	-0.157	-0.143
Weeks 7-9 post-marketing week 3	MM	-0.176	-0.310*	-0.121
		-0.195	-0.179	-0.198
Marketing + temporary discount				
Discount week 1	1D, MD	1.315***	0.546**	0.696***
		-0.203	-0.232	-0.144
Week 1 post-discount week 1	1D, MD	0.464***	0.578***	0.125
		-0.153	-0.212	-0.108
Week 2 post-discount week 1	1D, MD	0.428***	0.665***	0.161*
		-0.14	-0.159	-0.089
Week 3 post-discount week 1	1D, MD	0.386***	0.322*	0.109
		-0.139	-0.169	-0.105
Weeks 4-6 post-discount week 1	1D	0.116	0.175	-0.08
		-0.162	-0.151	-0.178
Discount week 2	MD	1.084***	-0.045	0.558**
		-0.287	-0.282	-0.236
Week 1 post-discount week 2	MD	0.331*	-0.508	0.052
		-0.168	-0.37	-0.135
Week 2 post-discount week 2	MD	0.329	-0.06	0.124
		-0.226	-0.222	-0.161
Week 3 post-discount week 2	MD	0.433**	-0.042	0.128
		-0.197	-0.291	-0.147
Post-discount marketing week 3	MD	0.313	-0.161	0.104
		-0.203	-0.282	-0.113
Week 1 post-marketing week 3	MD	0.368*	-0.034	0.037
		-0.217	-0.288	-0.151
Week 2 post-marketing week 3	MD	0.305*	-0.332	0.067
		-0.159	-0.285	-0.116
Week 3 post-marketing week 3	MD	0.178	-0.236	-0.05
		-0.178	-0.344	-0.145
Weeks 4-6 post-marketing week 3	MD	0.235*	0.181	0.038
		-0.138	-0.184	-0.098
Weeks 7-9 post-marketing week 3	MD	-0.094	-0.189	-0.173
		-0.16	-0.207	-0.135
Observations		3,329	2,967	3,455
R-squared		0.065	0.028	0.054
Number of shops		73	73	73

Shop-level fixed effects are included. Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A4. Impact on consumer awareness of promotion and aflatoxin (no endline controls)

	Names study brand as promoted	Names study brand as tested for aflatoxin	Can identify APTECA logo	Heard of aflatoxin	Identifies link between cancer and aflatoxin
Single marketing only (1M)	0.231***	0.081***	0.103	0.053	0.072***
	(0.039)	(0.029)	(0.088)	(0.043)	(0.022)
Multiple marketing only (MM)	0.278***	0.221***	0.034	0.084**	0.043*
	(0.039)	(0.037)	(0.066)	(0.033)	(0.022)
Single marketing + discount (1D)	0.368***	0.132***	0.010	0.049	0.055***
	(0.038)	(0.039)	(0.063)	(0.032)	(0.021)
Multiple marketing + discount (MD)	0.430***	0.152***	0.041	0.076**	0.051***
	(0.042)	(0.039)	(0.070)	(0.035)	(0.018)
Tests across treatments					
1M vs. MM	0.313	0.000	0.465	0.428	0.325
1D vs. MD	0.195	0.645	0.673	0.288	0.840
1M vs. 1D	0.00788	0.101	0.292	0.913	0.549
MM vs. MD	0.00175	0.119	0.937	0.801	0.773
Observations	1,225	1,225	1,225	1,225	1,225
Clusters	72	72	72	72	72
Mean, Control Group	0.0814	0.0747	0.240	0.762	0.0362

Notes: Shown are marginal effects of each treatment on the probability of a positive outcome, as estimated through a probit regression, with cluster-robust (shop-level) standard errors in parentheses. County fixed effects, location of interview (informal market vs. sample shop), log of pre-intervention weekly Tupike and total maize flour sales, pre-intervention mean price of other maize flour brands, and baseline shop-level means of respondent characteristics shown in Table A2 are included as controls. *** p<0.01, ** p<0.05, * p<0.1

Table A5. Impact on consumer experience and perceptions of Tupike (no endline controls)

		Favorable rating of Tupike's:				
	Has tried Tupike	Taste	Texture	Cooking time	Overall quality	Tupike is usual brand
Single marketing only (1M)	-0.014	0.039	-0.037*	-0.042	-0.016	-0.029
	(0.055)	(0.056)	(0.020)	(0.056)	(0.052)	(0.077)
Multiple marketing only (MM)	0.189***	0.187***	-0.050***	0.174***	0.156***	0.139***
	(0.030)	(0.047)	(0.019)	(0.040)	(0.044)	(0.044)
Single marketing + discount (1D)	0.183***	0.162***	-0.047***	0.165***	0.152***	0.182***
	(0.034)	(0.045)	(0.017)	(0.042)	(0.037)	(0.048)
Multiple marketing + discount (MD)	0.163***	0.172***	-0.040**	0.148***	0.114**	0.182***
	(0.042)	(0.047)	(0.019)	(0.045)	(0.049)	(0.065)
Tests across treatments						
1M vs. MM	0.000	0.016	0.375	0.000	0.001	0.028
1D vs. MD	0.602	0.834	0.645	0.718	0.451	0.994
1M vs. 1D	0.000	0.0291	0.498	0.000	0.001	0.009
MM vs. MD	0.500	0.752	0.518	0.565	0.432	0.508
Observations	1,225	1,225	1,225	1,225	1,225	1,225
Clusters	72	72	72	72	72	72
Mean, Control Group	0.695	0.613	0.0679	0.604	0.579	0.365

Notes: Shown are marginal effects of each treatment on the probability of a positive outcome, as estimated through a probit regression, with cluster-robust (shop-level) standard errors in parentheses. County fixed effects, location of interview (informal market vs. sample shop), log of pre-intervention weekly Tupike and total maize flour sales, pre-intervention mean price of other maize flour brands, and baseline shop-level means of respondent characteristics shown in Table A2 are included as controls. *** p<0.01, ** p<0.05, * p<0.1

Table A6. Impact on reported changes in maize purchases, past six months (no endline controls)

Ordered probit results -1=decrease 0=no change 1= increase	(1) Study brand	(2) All branded flours	(3) Unbranded flour	(4) Whole grains for grinding
Marketing (1M, MM)				
Decrease	-0.051***	-0.035*	0.045**	-0.003
	(0.012)	(0.021)	(0.018)	(0.025)
No change	-0.054***	-0.035*	-0.011*	0.001
	(0.016)	(0.021)	(0.007)	(0.008)
Increase	0.105***	0.07*	-0.033***	0.002
	(0.024)	(0.041)	(0.013)	(0.016)
Discount (1D, MD)				
Decrease	-0.044***	-0.031	0.039**	-0.001
	(0.016)	(0.020)	(0.017)	(0.028)
No change	-0.034**	-0.029	-0.009*	0.000
	(0.017)	(0.019)	(0.005)	(0.010)
Increase	0.078***	0.059	-0.03**	0.001
	(0.031)	(0.039)	(0.013)	(0.018)
Observations	1225	1225	1225	1225
Clusters	72	72	72	72
Proportion of respondents in control areas who report:				
Decrease	0.041	0.143	0.109	0.129
No change	0.880	0.473	0.785	0.854
Increase	0.079	0.385	0.106	0.066

Notes: Shown are marginal effects of each treatment on the probability of reporting a decrease, no change, or increase in consumption for each type of maize, as estimated through an ordered probit regression, with cluster-robust (shop-level) standard errors in parentheses. County fixed effects, location of interview (informal market vs. sample shop), log of pre-intervention weekly Tupike and total maize flour sales, pre-intervention mean price of other maize flour brands, and baseline shop-level means of respondent characteristics shown in Table A2 are included as controls. *** p<0.01, ** p<0.05, * p<0.1

Vivian Hoffmann is a Research Fellow at the International Food Policy Research Institute. **Christine Moser** is a Professor of Economics at Western Michigan University. **Timothy Herrman** is the State Chemist and Director of the Office of the Texas State Chemist and a Professor of Soil and Crop Sciences at Texas A&M University.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

1201 Eye Street, NW, Washington, DC 20005-3915 USA | T. +1.202.862.5600 | F. +1.202.862.5606 | ifpri@cgiar.org | www.ifpri.org

This IFPRI Research Note contains preliminary material and research results and is circulated in order to stimulate discussion and critical comment. It has not gone through IFPRI's standard peer-review procedure. Any opinions stated herein are those of the author(s) and are not necessarily representative of or endorsed by IFPRI. Funding for this work was provided by the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH) led by the International Food Policy Research Institute (IFPRI), and by the Global Center for Food Systems Innovation, established through the Higher Education Solutions Network of the United States Agency for International Development. The opinions expressed here belong to the authors, and do not necessarily reflect those of A4NH, IFPRI, CGIAR, or USAID.

Copyright remains with the authors. The authors are free to proceed, without further IFPRI permission, to publish this paper, or any revised version of it, in outlets such as journals, books, and other publications.