Asymmetric Expiration Bias between Healthy and Unhealthy Food Products

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Abstract

An expiration date generally refers to the date before which foods are at their peak quality. In general, food quality remains stable before the expiration date. However, there is a common belief among consumers that quality continuously deteriorates throughout the shelf life of food products. In this study, we investigate the nature of this "expiration bias". Building upon extant research, we hypothesize that the effect of approaching expiry on quality perception as well as sales is asymmetric between healthy foods (i.e., foods consumed mainly for nutritional benefits) and unhealthy foods (i.e., foods consumed mainly for sensory stimulation and pleasure). We test the asymmetry of this expiration bias in two ways. First, we analyze unique field data from an online salvage store where the information on expiration date is presented up front. Second, we pinpoint the driving mechanism of this bias using a laboratory experiment. The results of both parts of the study indicate that an expiration bias is consistently at work for healthy foods, but not for unhealthy foods. These findings imply that different pricing and communication strategies are needed for healthy and unhealthy foods. We run an additional field experiment to validate suggested strategies empirically in a real-life setting.

Keywords: Expiration bias; Expiration date; Healthy foods; Unhealthy foods; Online salvage store.

Retailers display expiration dates on packaging of food products to inform consumers about the estimated period of time by which food should be consumed (Donselaar et al. 2006; Sen and Block 2009; Theotokis, Pramatari and Tsiros 2012). In many cases, the notion of an expiration date is more conservative than might have been imagined. The United States Department of Agriculture (USDA) states that an expiration date is a date before which foods are at their peak quality, not a date after which foods are spoiled. The USDA also noted that because the quality of foods is mostly stable before the expiration date, the "expiration date is not an indicator of the product's safety".[1] However, consumers frequently and falsely believe that quality continuously deteriorates throughout the shelf lives of foods (Tsiros and Heilman 2005). In this study, we call this gap between reality (i.e., actual quality deterioration) and consumers' belief (i.e., consumers' belief on quality deterioration) *expiration bias*. Due to this expiration bias, retailers often sell nearly expired products at give-away prices (Theotokis, Pramatari and Tsiros 2012), even throwing them away to save the inventory cost (CNN 2013). This false belief causes enormous profit loss and high cost to the environment. Therefore, it is very important to understand the nature of expiration bias and to find marketing strategies to overcome it.

Prior research has verified the existence of expiration bias (Tsiros and Heilman 2005; Theotokis, Pramatari and Tsiros 2012). The scope of these studies was, however, limited only to fresh foods such as vegetables, dairy products, poultries, and meats, although there are many other types of food products. Consumers may or may not show a similar expiration bias for other food products. At grocery stores, consumers encounter various types of food products such as chocolate, snacks, nutrition bars, cereals, frozen foods, and so on. These can be broadly

[1] Please refer to the USDA webpage for details (https://goo.gl/GFJTTc).

categorized as follows depending on the purpose of consumption (Dhar and Waterbroch 2000; Milkman and Rogers 2010; Mishra and Mishra 2011; Shiv and Fedorikhin 1999): (1) healthy foods that are consumed mainly for their health benefits, and (2) unhealthy foods that are consumed for other reasons such as sensory stimulation and pleasure. In this study, we pose the following research question: do consumers exhibit the same expiration bias for healthy and unhealthy food products?

In this study, we examine expiration bias in these two food categories. Building upon extant research, we identify a crucial psychological antecedent for expiration bias. Then, we predict that consumers expect quality deterioration for non-fresh foods in the healthy foods category (e.g., nutrition bars) just as they do so for fresh foods. When purchasing unhealthy foods (e.g., chocolate bars), however, we predict that expiration bias will be less evident.

We test our predictions using both econometric and experimental methods. First, we analyze unique field data from an online salvage store where the information on expiration date is presented up front for each product on the website. Data are analyzed regarding daily sales, sales price, and supply price of 1,029 nearly expired foods; the results of the deliberate econometric analyses support our theoretical conjecture. Second, we test our predictions using a laboratory experiment to isolate the effect of primary interest. Again, the results verify the presence of an asymmetric expiration bias in quality perception between healthy and unhealthy foods.

This difference in expiration bias between healthy and unhealthy foods implies that different marketing strategies may be necessary for each type. For nearly expired, unhealthy foods, retailers may not need any additional discount because the expiration date does not influence quality perception. For nearly expired healthy foods, however, a price discount may be a valid pricing strategy because consumers avoid purchasing these foods based on their

perception that the quality has deteriorated. For additionally discounted, nearly expired, healthy foods, retailers may prefer to use an alternative phrase like "inventory clearance sales" to alleviate expiration bias to some extent. We validate the efficiency of proposed pricing and communication strategies in a series of additional studies including a field experiment.

Our study makes the following contributions. First, we identify the psychological conditions for expiration bias by examining a variety of foods consumed for different reasons. Our findings suggest that expiration bias is not as widespread as one might have imagined; it is at work only when health is a major motivation for food consumption. This research not only extends the scope of previous studies, but also enriches our understanding of the nature of expiration bias. Second, while prior research investigated expiration bias using survey and hypothetical scenarios (Tsiros and Heilman 2005; Theotokis, Pramatari and Tsiros 2012), to our best knowledge, this paper is the first to investigate expiration bias in the marketing literature using field data on actual consumption behavior, allowing us to examine expiration bias rigorously. Because information on expiration date is highlighted on product websites, where rich information on supply and selling price is available, we can rule out alternative explanations. Third, beyond providing evidence of expiration bias, we propose specific marketing strategies for retailers. Proposed pricing and communication strategies to combat expiration bias are immediately actionable, as their efficiencies are validated via a series of experiments.

THEORY AND HYPOTHESES

Expiration Dates of Food Products

As stated earlier, an expiration date refers to a previously determined date before which a food is at "peak" quality; however, food quality is mostly stable during a product's shelf life (CNN

2013; Consumer Reports 2015; Cosmos 2016; Sen and Block 2009; Theotokis, Pramatari and Tsiros 2012; Tsiros and Heilman 2005). Nonetheless, it has been widely reported that customers falsely believe that the quality of a food deteriorates as it approaches expiry (Gregory, Slovic and Flynn 1996; Péneau et al. 2006; Sen and Block 2009; Theotokis, Pramatari and Tsiros 2012; Tsiros and Heilman 2005). In this study, we call this misconception "expiration bias" in terms of quality perception.

Past research has examined expiration bias in the context of fresh foods. For instance, Tsiros and Heilman (2005) conducted a survey of retail shoppers and found that consumers' willingness to pay for fresh foods such as milk, yogurt, beef, chicken, lettuce, and carrots decreases as the expiration date approaches. In a series of experiments, Theotokis, Pramatari and Tsiros (2012) documented that customers consider price discounts for nearly expired dairy products as a trade-off between quality and cost. Although these studies shed light on the phenomenon of expiration bias, the scope of their analyses is restricted to fresh foods such as vegetables, dairy products, poultries, and meats. Hence, it is not clear whether a similar expiration bias is present for other types of food products.

Consuming Healthy versus Unhealthy Foods

Food research has categorized foods into two categories based on the motivation of consumption: healthy and unhealthy foods. Healthy foods are consumed to acquire nutrients for growth and functioning of the body system (Jackson et al. 2003; Renner et al. 2012; Schupp and Renner 2011; Smith 2004; Tylka 2006). Foods known to be beneficial to human health such as organic foods, foods with natural ingredients, and low-fat foods are often categorized as healthy foods. In contrast, unhealthy foods are consumed for the experience of pleasure from sensory stimulation and include things such as chocolate, sugary drinks, and junk foods

(Jackson et al. 2003; Macht and Simons 2000; Raghunathan, Naylor and Hoyer 2006; Sproesser et al. 2011).

When consumers purchase healthy foods, they consider their wholesomeness and benefits to health, which is the most important standard in food evaluation (Baltzer 2003; Krystallis and Chryssochoidis 2005; Röhr et al. 2006; Torjusen et al. 2001). In addition, consumers often determine the quality of healthy foods based on objective facts associated with their wholesomeness such as nutrition contents (Oakes 2005), organic qualities (Doorn and Verhoef 2011), and low cholesterol (Urala and Lähteenmäki 2004).

Consumers also consider freshness, the state of being recently made or harvested, as an important factor indicating the wholesomeness or quality of a product (Wandel and Bugge 1997). Indeed, past research has reported that the "healthfulness" and safety of foods are believed to be highest for newly made products and to decline as time passes (Wansink and Wright 2006). Hence, it is reasonable to assume that expiration dates would provide important information that determines the quality of healthy food products. Based on this line of reasoning, we develop a hypothesis regarding the expiration bias of healthy foods:

H1a: The perceived quality of a healthy food product decreases as it approaches its expiration date.

When consumers purchase unhealthy foods, consumption is motivated by hedonic needs (Baltzer 2003; Krystallis and Chryssochoidis 2005; Röhr et al. 2006). In consuming these foods, consumers focus more on the pleasure derived from sensory experiences than the wholesomeness of the food (Baltzer 2003; Krystallis and Chryssochoidis 2005; Röhr et al. 2006; Torjusen et al. 2001). Accordingly, quality evaluation of unhealthy foods will be based on different criteria from that for healthy foods; consumers evaluate the quality of unhealthy foods based on sensory stimulation, which elicits immediate satisfaction due to things such as

pleasing taste (Raghunathan, Naylor and Hoyer 2006), pleasing odor (Alba and Williams 2013), emotive imagery (Thomas, Desai, and Seenivasan 2010; Kushwaha and Shankar 2013), and even visceral experience from past consumption of the product (Alba and Williams 2013; Loewenstein 1996).

Time until expiry is not a sensory attribute that stimulates hedonic desire (Ragaert et al. 2004). Therefore, we posit that quality evaluation based on time until expiry would be limited for unhealthy foods. Therefore, we conjecture that expiration bias in quality perception is asymmetric between healthy and unhealthy foods, hypothesizing as follows:

H1b: The perceived quality of an unhealthy food is less affected by the time until its expiry date than a healthy food.

Now, we turn our focus to the association between the time left to expiry and food sales, which may be of greater interest to practitioners than quality perception *per se*. Obviously, a change in quality perception will affect sales when all else remains unchanged (Grewal, Monroe, and Krishnan 1998; Sweeny, Soutar, and Johnson 1999; Wells, Valacich, and Hess 2011; Zeithaml 1988). In this study, we posit that the asymmetric expiration bias in quality perception between healthy and unhealthy foods will result in an asymmetric expiration effect on sales. Hence, we hypothesize the following:

H2a: The sales of a healthy product decreases as it gets closer to its expiration date.

H2b: The sales of an unhealthy product is less affected by the time until its expiration date than healthy products.

We test these hypotheses in two separate studies. Study 1 examines the sales of online retailers using econometric methods to investigate the asymmetric effect of expiration bias on sales (H2). Study 2 examines the asymmetric effect of expiration bias on quality perception

(H1) as a precedent of the asymmetric expiration effect on sales (H2) in an experimental setting. We discuss each study in more detail in the following two sections.

STUDY 1: FIELD DATA ANALYSES

Research Setting

In Study 1, we start by testing for the asymmetric impact on sales of the time until expiration (H2). This is because sales are readily observable by marketing managers, unlike perceived quality, and also of greater importance to managers than perceived quality *per se*.

To investigate for this effect, the research setting needs to satisfy the following three conditions. First and foremost, it must be a setting where customers recognize the expiration date of a product in making their purchase decisions. If information about the expiration date is not readily available or unimportant, there is no reason to believe that an approaching expiration date would have an impact on sales. Second, temporal changes in price must be observed. As outlined earlier, retailers tend to cut the price of a product as it approaches its expiration date (Theotokis et al. 2012; Tsiros and Heilman 2005). Without a proper control on price changes, therefore, estimation of the expiration effect may be seriously biased by a strong correlation between price and sales. Third, we need additional information to deal with price endogeneity. As noted by previous researchers (e.g., Chintagunta, Dube and Goh 2005; Vilas-Boas and Winers 1999), retailers' pricing decisions tend to be inherently strategic; for instance, there could be more price discounts for less popular products. To handle the endogeneity issue effectively using the instrumental variable (hereafter, IV) approach (e.g., Greene 2012; Wooldridge 2015), we need a strong instrument which is closely related to price changes, but not directly related to sales, such as supply price.

For the empirical analyses, we collected a data set from one of the iconic online

retailers in South Korea, a data set unique and novel in that it satisfies all three requirements above.[2] This retailer has sold various products, mostly edible, such as snacks, foods, and nutrition supplies since its launch in 2013, and is well known for its unique business model; it buys products close to expiration date from manufacturers at give-away prices and sells them to customers at lower than regular prices. Having gained the favor of both suppliers and price-sensitive consumers by providing a unique channel for soon-to-be discarded products, the business has been very successful; the website grew by 26% in 2015 and had 130,000 active users on its website in 2016.

(Insert Figure 1 about here)

This retailer satisfies the three conditions for the following reasons. First, the information on the expiration date is presented up front on the website. Figure 1 is a screen shot of the product list page on the online store. It is worth noting that the expiration date of each product is clearly displayed in a large font at the beginning along with other key features such as product title, original price, discounted price, and discount rate; this is part of the website's unique business model. Thus, we can presume that customers consider the expiration date in making their purchases, which fulfils the requirement in our research setting. This is in contrast to the websites of other retailers, where customers may not see the expiration date, as they need to go through the detailed product description to find it. Second, the online store provides detailed information about the price. In fact, our data contains not only the selling price of each product every day, but also the supply price of each product, which is known to

[2] For reasons of anonymity agreed upon with the website, we do not report its identity.

be a useful IV when investigating price endogeneity (Petrin and Train 2010; Villas-Boas and Zhao 2005). In our research setting, therefore, we can identify the effect of approaching expiration date with no interference from temporal changes in price or price endogeneity.

Data

The data set includes information about daily sales, daily price (i.e., original, selling, and supply prices), expiration date, and product category of all products registered on this website in 2015 (4,399 different products).

Our data selection process was based on three criteria to ensure the validity of the results of our empirical analyses. First, we restricted the analysis to the snack category. We selected this category because there are both healthy (e.g., nutrition bars and organic nuts) products and unhealthy products (e.g., chocolate and jelly) for comparison in this category. This is in contrast to other categories where most products are classified as one or the other (e.g., most medicines are categorized as healthy products). Also, products in the same category tend to share similar unobservable characteristics, so we can measure the effect of the variable of focal interest more precisely while balancing the effect of potential confounders by focusing on a single category. For these reasons, our analysis focuses on 1,029 products in the snack category.

Second, we excluded from our analyses observations of products with 100 or more days left until the expiration date. During the study period, the majority of products had been registered on the website when they had less than 100 days left to the expiration date, but for a few products, there was a year until the expiry date. Concerned that those outlying observations would dominate in the estimation process and skew the results, we decided to focus on observations with less than 100 days left to the expiration date. Also, we believed that the effect

of the approaching expiration date would be salient when the product expiry date was sufficiently close, and that 100 days left until expiration was a sufficient amount of time.

Third, we excluded observations of products not on sale. In this online store, products past their expiration dates are not sold. Also, four products that were sold out before reaching their expiration dates disappeared from the product list page. For these observations, sales values are always zero; therefore, we eliminated them from our data set.

In the end, 27,561 observations for 1,029 products in the snack category were included in our empirical analysis. Since most products had less than 100 days left until their expiration dates and several products were sold out before reaching their expiration dates, the following equation applies: total number of observations, 27,561, which is less than 102,900 = 1,029 products $\times$ 100 days.

Variables

We use the following variables for our empirical analysis. First, $sales_{it}$ denotes the number of product i's units sold on calendar day t. Given our research question, this variable is our dependent variable; its values were log-transformed in our analysis due to right-skewness. Next, $daysleft_{it}$ denotes how many days remain until product i*'s* expiration on calendar day t, which is the key independent variable of interest. The variable takes a value of 0 on the expiration date, so values range from 0 to 99 in our data set.

Another key variable is $unhealthy_i$ which takes a value of 1 if a product i is classified as unhealthy and 0 otherwise. We categorized products that contain organic ingredients, include nutrition highlights, and dried fruit and nuts without chemical additives as healthy products, and all remaining snacks were defined as unhealthy products. As a result, 163 products were categorized as healthy products and 866 products were categorized as unhealthy products. This

variable tests if the effects on sales of an approaching expiry date vary between healthy and unhealthy products. Figure 2 shows the trends in average sales of healthy and unhealthy products over the days left until expiration. We can see that the sales of healthy products decrease as the expiration date approaches (i.e., to the right in the figure), while the sales of unhealthy products remain relatively more stable. This descriptive pattern is consistent with our hypothesis. In the next section, we build and estimate an empirical model for more rigorous analysis.

(Insert Figure 2 about here)

To control for the effect of temporal changes in price, we define $discount_{it}$ as the additional discounted percentage on product i on day t compared to its discount in the initial observation in our data. More specifically, the variable is defined as the additional discount divided by the initial discount; for instance, the variable takes a value up 50% (=100×($15-$10)/$10) when the initial discount is $10 and the discount on day t is $15. By construction, $discount_{it}$ must be 0 in the initial period. This variable controls for the confounding effect of price, which may be negatively correlated with the number of days left until the expiration date.

Table 1 presents the summary statistics for the focal variables discussed so far. As noted in previous literature, $discount_{it}$ and $daysleft_{it}$ have a negative relationship (i.e., the discount increases as the expiration date approaches), which necessitates control of price changes to identify the direct effect of the approaching expiration date on sales. In addition, the negative correlation hints that pricing decisions might be made in a strategic fashion (i.e., the firm heavily discounts soon-to-be-expired products). Therefore, it is necessary to deal with price endogeneity in our empirical analysis.

(Insert Table 1 about here)

Model

In this section, we specify the empirical model for our analyses. Equation 1 is specified as:

$$(1) \qquad \ln(sales_{it}) = \beta_{0i} + (\beta_1 + \beta_2 unhealthy_i) daysleft_{it} + (\beta_3 + \beta_4 unhealthy_i) discount_{it} + X_t\beta_5 + \varepsilon_{it}$$

where the sub-indices i and t denote product and calendar day, respectively. β_{0i} denotes the product-specific fixed effects assuming different baselines across products (1,028 dummies). The purpose is to control for differences in average sales across different products, in order to identify the effect of interest better.

The effect of the time until expiry on sales is captured by β_1 and β_2. More specifically, β_1 captures the effect of the number of days left until expiration on healthy product sales, and β_2 captures its differential effect on unhealthy product sales compared to healthy product sales. Therefore, a value for β_1 greater (smaller) than 0 implies that the sales of healthy products decrease (increase) as the expiration date approaches, and a value for β_2 greater (smaller) than 0 implies that an approaching expiration date has relatively more negative (positive) effects on unhealthy product sales compared to healthy product sales.

Similarly, the effect of an additional price discount is captured by β_3 and β_4. As explained earlier, the variable controls for the confounding effect of temporal price changes and helps identify the effect of an approaching expiration date on sales. Although the effects are not of focal interest, we allow the effect to vary between healthy and unhealthy products in order to control for different levels of sensitivity to additional price cuts between product categories. The interpretation of the two parameters is analogous to β_1 and β_2.

Next, X_t is a vector of the control variables on calendar time and β_5 is a vector of

corresponding parameters. More specifically, it includes dummy variables for the day of the week (6 dummies) and dummy variables for months (11 dummies), which control for a temporal shift in sales as time passes. Finally, ε_{it} denotes i.i.d., a distributed error term with a mean value of 0.

As discussed earlier, $discount_{it}$ in the sales equation may potentially cause an endogeneity problem because decisions about price discounts may be correlated with some unobservable factors that affect purchase decision-making (Kim and Petrin 2012; Petrin and Train 2010). To deal with this problem, we employ the 2SLS estimator (e.g., Greene 2012; Wooldridge 2012) using IV constructed from our information on supply price. Our IV equation is then specified as follows:

$$discount_{it} = \tau_{0i} + \tau_1 margin_{it-1} + \tau_2 profit_{it-1} + \eta_{it} \quad (2)$$

where τ_{0i} indicates a product-specific intercept variable and η_{it} denotes the i.i.d. distributed error term with a mean value of 0.

For the IV, we use $margin_{it-1}$ and $profit_{it-1}$, where $margin_{it-1}$ denotes the lagged product margin (i.e., sales price minus supply price) that the website can earn by selling one unit of product i at period t-1 and $profit_{it-1}$ is defined as total net sales profit by selling product i in period t-1 (i.e., $sales_{it-1} \times margin_{it-1}$). Both variables are defined in Korean currency (KRW, ₩). Obviously, customers do not observe these variables, so they do not directly affect sales. However, the online retailer can determine the appropriate additional discount on a product by considering the amount of room for the additional discount (i.e., $margin_{it-1}$) and how well the product has sold recently (i.e., $profit_{it-1}$). For instance, the company may not want to place an additional discount on a product with low $margin_{it-1}$ in order to preserve a non-negative profit. Also, the company may want to place an additional discount on a product contributes little to

its overall profitability. For these reasons, $margin_{it-1}$ and $profit_{it-1}$ are expected to influence sales indirectly via the sales price; therefore, they work as valid IVs. The effects of our IV variables on $discount_{it}$ are captured by τ_1 and τ_2, respectively.

Finally, following the literature using IV regression, Equation 2 includes all the independent variables included in Equation 1, which we denote by Z_{it}, and τ_3 is a vector of the associated parameters.

Results

The results of the estimation for the parameters of interest are summarized in Table 2. Consistent with H2a, the sales of healthy products are greater when there is more time left until the expiration date ($\hat{\beta}_1$= .32, p < .01). In other words, the sales of healthy products decrease as the expiration date approaches. Consistent with H2b, in addition, there is significant evidence that the effects of expiration dates on sales differ between healthy and unhealthy products; the sales of unhealthy products are significantly less sensitive to the time left until expiration than healthy products ($\hat{\beta}_2$= -.37, p < .01).

(Insert Table 2 about here)

(Insert Figure 3 about here)

The asymmetric effects of expiration dates on sales between healthy and unhealthy products are visualized in Figure 3. As mentioned earlier, the effect of expiration bias for healthy products is consistent with conventional belief. For unhealthy products, however, there is no significant evidence that sales of unhealthy products are associated with the time left to the expiration date ($\hat{\beta}_1+\hat{\beta}_2$ = -.05, p =.38). In sum, our finding implies that expiration effects

are at work only in the purchase of healthy products, not in the purchase of unhealthy products.

Another interesting finding is that the effects of additional discounting, $\hat{\beta}_3$ and $\hat{\beta}_4$, exhibit similar patterns to those of the expiration effect, $\hat{\beta}_1$ and $\hat{\beta}_2$. It turns out that the additional price discounts increase the sales of healthy products ($\hat{\beta}_3$= 2.09, p <.01), but not the sales of unhealthy products ($\hat{\beta}_3 + \hat{\beta}_4$ = -.75, p =.44). Although the asymmetric expiration bias in quality perception is not directly tested in this analysis, the findings are consistent with our claim that consumption of unhealthy snack foods is more motivated by sensory stimulation than by objective facts such as expiration date and price.

Discussion

In Study 1, we found that the effect of an approaching expiry date has an asymmetric effect on sales. Consistent with our hypotheses, sales of healthy foods decrease as the expiry date approaches, but sales of unhealthy foods are not affected. Although we derive our estimation results from an empirical analysis using deliberate econometric methods and a novel data set, there are several limitations to this study.

First, the selection problem may have influenced the results. In our data, the customers "decided" to purchase healthy or unhealthy products. If these two types of products are purchased by different groups of customers, our findings may simply present the pattern that health food lovers care about product expiration, while lovers of unhealthy foods do not. To claim that this finding is not driven by customer heterogeneity, but by asymmetric expiration bias for different product categories, we need to solve this selection problem.

Second, although our empirical model shows that an asymmetric expiration effect is at work for sales, it does not elucidate expiration bias in quality perception. That is, we cannot rule out alternative mechanisms that may have driven the effect of expiration dates on sales.

For instance, lower sales of nearly expired products may not be driven by perceived lower quality, but by concerns that those products may not be used up before they expire. To address these concerns, we ran the following experiment.

STUDY 2: EXPERIMENTAL STUDY

The objective of Study 2 is twofold. First, we aim to reaffirm the findings of Study 1 in a different setting where the potential concerns discussed in Study 1 (e.g., selection problem) are addressed. For that purpose, we use an experimental method where participants are randomly assigned to different conditions. Each condition is manipulated by varying the food category (healthy vs. unhealthy) and time until expiry (long vs. short), so we can isolate the effect of interest from potential confounders and alternative explanations.

Second, we investigate the possibility of asymmetric expiration bias in quality perception (H1) as a driver of the findings in Study 1. In our hypotheses, we proposed that customers asymmetrically infer product quality from the time until expiry (H1), and that this results in an asymmetric effect on sales (H2). To illustrate that the proposed mechanism is at work, we asked study participants to judge the quality of several products, which is rarely observed in studies involving field data. In addition, we assessed their maximum willingness to pay (WTP), which is presumably related to sales.

Method

We recruited a total of 248 participants through an online survey system, Mechanical Turk (MTurk). Participants were residents of the U.S. (50% female, mean age: 34.7). They participated in this study for monetary rewards. Four participants did not complete the study; their responses were therefore excluded from the analyses. We used a 2(type of product: healthy

vs. unhealthy) × 2(time left to expiration: short vs. long) between-subjects design. We randomly assigned participants to one of these conditions.

We used a nutrition bar for healthy food and a chocolate bar for unhealthy food. We chose these foods because they are very similar in looks and price, but differ in terms of consumption motivation: while consumers eat nutrition bars for their health benefits, consumers eat chocolate bars for their taste and sweetness. To manipulate the amount of time until expiration, we referred to the sales data in Study 1. We used 100 days for long time to expiry as it is the longest time to expiry in the data, and 10 days for short time to expiry as the sales gap between healthy and unhealthy foods increases around that day.

The study started with general statements about health consciousness (i.e., "I am health conscious"), self-control (i.e., "I devote time and effort to preparing for the future"), planned purchasing (i.e., "I plan my purchases"), snack consumption (i.e., "I often eat a chocolate bar/nutrition bar"), [3] and attitude toward the focal snack (i.e., "I would like to eat this chocolate/nutrition bar"). These items represent factors that may potentially influence consumers' snack consumption (Alba and Williams 2013; Thomas, Desai and Seenivasan 2011). Participants indicated their responses on a 7-point scale (1 = not at all, 7 = very much). The responses to these questions were used to control individual differences in attitude towards snack consumption.

In the main part of the study, participants saw a picture of a snack with the information on its expiration date and the time left until expiry. More specifically, participants assigned to the healthy condition saw a picture of a nutrition bar, and those who were assigned to the unhealthy condition saw a picture of a chocolate bar. To relieve participants' concerns about

[3] Respondents assigned to the healthy condition were asked about the frequency of nutrition bar consumption, while those assigned to the unhealthy condition were asked about the frequency of chocolate bar consumption.

not finishing the products before their expiration date, we labelled each product as intended for single usage to rule out the alternative explanation that respondents' different expectations about consumption speed might affect purchase decisions. Figure 4 displays the snapshots that participants saw in the experiment. For instance, a participant saw a nutrition bar with 100 days left to the expiration date in Figure 4a if she was in the healthy-long (i.e., 100 days left) condition, and a chocolate bar with 10 days left to the expiration in Figure 4b if she was in the unhealthy-short (i.e., 10 days left) condition.

(Insert Figure 4 about here)

Then, we asked all participants to reveal their maximum WTP for the product they saw. As noted in previous literature, maximum WTP is closely related to product sales; higher maximum WTP will result in greater sales when all else is unchanged (Infosino 1986; Wertenbroch and Skiera 2002). Therefore, we use the maximum WTP to replicate the findings in Study 1 and find further support for our hypothesis about the asymmetric expiration effect on sales (H2). For maximum WTP, participants were asked to write the dollar value of the maximum price they would be willing to pay for the product (i.e., "What is the maximum price you would be willing to pay (USD, $) for this chocolate bar?").

In addition, we collected data on participants' perceived quality of the product they saw in order to test for asymmetric expiration bias in quality perception (H1) and show that the proposed mechanism is at work. Consistent with past studies (Boulding et al. 1993; Peterson 1970; Phillips, Chang and Buzzell 1983; Rust et al. 1999; Yan, Sengupta and Wyer Jr. 2014), we explained quality perception as "your perception about the overall superiority of the product" in the survey. Participants indicated their perceived quality of the product on a scale of 1 to 100

(i.e., "What is your perceived quality of a chocolate bar (nutrition bar) which expires in 10 (100) days?") where 1 is for the poorest quality and 100 is for the best quality.

Results

Asymmetric expiration effect on sales. To test for the asymmetric expiration effect on sales between healthy and unhealthy products (H2), we used 2-way ANCOVA of WTP where self-control, health consciousness, tendency to plan purchase, snack consumption, and the attitude toward the product were used as covariates.

As predicted, we found a significant interaction between time until expiry and product category ($F(1, 239) = 5.08$, $p < .05$). This finding is consistent with H2b that the effect of the expiration date on WTP will be more pronounced for healthy products than for unhealthy products. More specifically, we found a significant effect of the expiration date on WTP for the healthy product, but not for the unhealthy product. We used simple effect analysis (Keppel and Wickens 2004) to test the effect of the expiration date on WTP in the healthy category, and found significantly higher WTP for products with longer times until expiration than that of nearly expired products ($M_{healthy\text{-}long} = 1.55$ vs. $M_{healthy\text{-}short} = 1.13$; $F(1, 239) = 6.94$, $p < .01$). However, the effect was not symmetric between the two categories, that is, time left until expiration has no significant effect on WTP for unhealthy products ($M_{unhealthy\text{-}long} = 1.39$ vs. $M_{unhealthy\text{-}short} = 1.46$; $F(1, 239) = .24$, $p = .63$). The findings clearly indicate that the effect of the expiration date on WTP differs between the categories and is at work for healthy products only. The results are visualized in Figure 5a.

As noted earlier, higher maximum WTP results in greater sales when all other factors are unchanged. Consistent with the results in Study 1, therefore, our findings indicate that approaching expiration has asymmetric effects on sales between healthy and unhealthy

products. The consistent results in the field and experimental studies establish the asymmetric effect of the expiration date on sales, as predicted.

Asymmetric expiration bias on quality perception. To understand the underlying mechanism, we investigated the expiration bias on quality perception. If our proposed mechanism (i.e., the time until expiry affects perceptions of the quality of healthy products, but not that of unhealthy products) drives the asymmetric effect of the expiration date on sales, we would expect to find an effect of the asymmetric expiration bias on quality perception as well (H1). Analogous to the analysis above, we used 2-way ANCOVA of perceived quality where self-control, health consciousness, and the frequency of focal product consumption were used as covariates.

As we predicted, the interaction between product type and approaching expiration on perceived quality was significant ($F(1, 239) = 4.79$, $p < .05$). That is, the degree to which a customer relies on the time until expiry for inferring product quality differed between healthy and unhealthy products. The results of a simple effect analysis indicate that the perceived quality of the healthy products was significantly higher when the time to expiration was longer ($Q_{healthy\text{-}long} = 77.76$ vs. $Q_{healthy\text{-}short} = 58.34$; $F(1, 239) = 14.2$, $p < .01$). This result is consistent with H1a, which posits that the time left until expiration influences perceived quality for healthy products. In contrast, perceived quality of unhealthy products was unaffected by the time left to the expiration date ($Q_{unhealthy\text{-}long} = 65.32$ vs. $Q_{unhealthy\text{-}short} = 60.2$; $F(1, 239) = 1.12$, $p = .29$). These results are visualized in Figure 5b.

(Insert Figure 5 about here)

In sum, the asymmetric expiration bias on perceived quality is analogous to the effect

on sales; it is significantly different between healthy and unhealthy products, and at work for healthy products only. If this effect on sales was driven by alternative mechanisms (e.g., concerns that one cannot use up the product before expiry, concerns that one has limited choices for when to consume the product), we would not have seen the asymmetric expiration bias in quality perception. Therefore, the findings falsify the notion that the asymmetric effect of the expiration date on sales was driven by a mechanism other than different inferences about quality based on the time until expiry between healthy and unhealthy products.

Mediation analysis. We further showed that the difference in expiration bias between healthy and unhealthy foods is the process behind the asymmetric effect of the expiration date on sales. For that purpose, we conducted a mediation analysis using the PROCESS SPSS macro (Model 8; Hayes 2012; Preacher and Hayes 2004). Key variables and the model framework are presented in Figure 6; we used the time until expiration as the independent variable, WTP as the dependent variable, quality perception as a mediator, and product type as a moderator in the mediation analysis.

(Insert Figure 6 about here)

The results are summarized in Table 3. In the table, the first column presents the effects of the variables on quality perception. The findings in the earlier analyses are well replicated in this analysis. The perception of the quality of healthy products significantly deteriorates as the expiration date approaches (β = -19.42, SE = 5.15, t = 3.77, CI(-29.57, -9.27), $p < .01$). However, the expiration bias on quality perception differs significantly between healthy and unhealthy products (β = 14.28, SE = 7.06, t = 2.02, CI(.35, 28.2), $p < .05$), and the perception of the quality of unhealthy products turns out to be unaffected by approaching expiration (β =

14.27-19.42 (= -5.15), SE = 11.38, t = .36, CI(-18.15, 26.45), $p > .50$).

(Insert Table 3 about here)

The second column in the table presents the effects of the variables on WTP. As we expected, perceived quality was significantly associated with WTP ($\beta = .005$, SE = .002, t = 2.3, CI(.007, .009), $p < .05$), and therefore an important antecedent for WTP. To further confirm the mediation process, we tested the indirect effect (i.e., the effect of time until expiry on WTP mediated via perceived quality) conditional on each category. The conditional indirect effect was estimated as the mediation effect depending on the moderator's conditions using bootstrapped confidence intervals. The estimates showed that perceived quality significantly mediated the effect of the expiration date on sales of healthy products ($\beta = -.09$ SE = .045, Z = 2, CI(-.20, -.02), $p < .05$). However, there is no such mediating relationship for unhealthy products ($\beta = -.023$ SE = .027, Z = -.67, CI(-.10, .01), $p > .50$), as the perception of product quality is unaffected by the time until expiry. These findings are consistent with the proposed mechanism that inferences about quality based on time until expiration leads to asymmetric effects of the expiration date on sales between healthy and unhealthy products.

Additionally, it is interesting to note that approaching expiry has a significant direct effect on WTP, which was not moderated by perceived quality ($\beta = -.34$, SE = .17, t = -2.04, CI(-.66, -.01), $p < .05$). The finding implies that the effect of the expiration date on sales may be driven by mechanisms other than quality perception. As mentioned earlier, nearly expired products may raise concerns that the product will not be used up before it expires, even if we explicitly labelled each product as intended for single usage for the benefit of survey respondents. Also, shorter time to expiry may have reminded them that they had less choice

about when to consume it, whether or not she was in the mood to consume the product. Nonetheless, the key finding is that the direct effect of the expiration dates on sales did not differ between healthy and unhealthy products (β = -.43, SE = .22, t = 1.95, CI(-.003, .87), p = .52). In other words, there could be several mechanisms other than quality perception driving the expiration effect, but they do not lead to asymmetry between healthy and unhealthy products. Therefore, the asymmetric effect of the expiration date on sales is definitely driven by the proposed mechanism wherein customers infer product quality from the time until expiry differently for products in different categories.

Discussion

The results of Study 2 can be summarized as follows. First, we reconfirmed the asymmetric effect of the expiration date on sales between healthy and unhealthy products (H2). In Study 1, we documented evidence of this effect on sales by analyzing actual consumer behavior. In Study 2, we replicated these results and ruled out potential concerns about internal validity in our experimental setting. Therefore, we can establish that the effect of the expiration date on sales is asymmetric between healthy and unhealthy products.

Second, we showed that the proposed mechanism drives the asymmetric effect of the expiration date on sales. If customers' inferences about quality based on the expiration date differ between healthy and unhealthy products, as we proposed, the expiration bias should be asymmetric in quality perception as well. We documented evidence of an asymmetric expiration bias on quality perception (H1). Additionally, the mediation analysis revealed that the perception of quality mediated the effect of the expiration date on sales of healthy products, but not that of unhealthy products, as their quality is unaffected by the time until expiry.

Finally, we highlight that the proposed mechanism is a major driver behind the

asymmetric effect of the expiration date. Our findings implicitly suggest that there could be alternative mechanisms driving this effect. However, it turned out that the effect driven by those mechanisms does not exhibit asymmetry between healthy and unhealthy products. As we proposed, therefore, the asymmetric effect of the expiration date on sales was mainly driven by asymmetric inferences about quality, where customers infer the quality of healthy products based on the time left to expiry, but not that of unhealthy products.

MANAGERIAL IMPLICATIONS

According to the results of our studies, the approaching expiration date for healthy products depreciates the perceived quality of those products and leads to decreases in sales. In contrast, the perceived quality and sales of unhealthy products are unaffected by an approaching expiration date. These results clearly indicate that practitioners who aim to sell products nearing their expiration dates need to employ different marketing strategies for healthy and unhealthy products. In this section, we specifically discuss i) pricing and ii) communication tactics for healthy and unhealthy products as the number of remaining days to expiration decreases.

Pricing Strategy: Counterfactual Analysis

Many retail shops and grocery stores indiscriminately discount products with very few days left to expiration date (Donselaar et al. 2006). However, our findings suggest that the pricing strategy for near expiry healthy and unhealthy products needs to differ substantially. We found that sales (Study 1) and WTP (Study 2) of healthy products decrease as the expiration date approaches. This finding implies that applying a price discount for a healthy product close to the expiration date can be an effective way to sell the product. This is consistent with

conventional marketing efforts that heavy discounts should be placed on products close to the expiration date (Afshar-Nadjafi 2016; Wang et al. 2015). By contrast, an approaching expiration date influences neither the sales (Study 1) nor the WTP (Study 2) of unhealthy products. This finding implies that a significant amount of profit can be lost by placing unnecessary price discounts on unhealthy products.

The results from a simulation study further confirm our claim. In a simulation analysis using the data in Study 1, we compute the hypothetical profits under two different scenarios of pricing strategy: i) an observed actual pricing scheme where there are additional discounts for products as they approach the expiration date within the observation period (i.e., less than 100 days left to the expiration date) and ii) a counterfactual pricing scheme where there is no further discount during the period. In the observed pricing scheme, 242 out of 866 unhealthy products had additional discounts averaging 10.4% while 69 out of 163 healthy products had additional discounts averaging 8.6%. Net profit under the suggested pricing scheme was directly obtained from the observed data; actual daily profits of all observations were aggregated within each category. Hypothetical net profit with no additional discount was computed based on the estimate of our model parameters; we predicted daily sales for all observations under the hypothetical setting where there is no additional discount ($discount_{it} = 0$) given the estimated parameters, calculated predicted daily profit using predicted daily sales, and then aggregated predicted daily profit of all observations by category.

For healthy products, we found that the observed pricing scheme (i.e., additional discounts for a product as it approaches its expiration date) is more profitable than the no-further-discount policy. Indeed, the profit using the observed pricing policy is 1% greater than that under no-further-discount policy. By contrast, the no-further-discount strategy is a better one for selling unhealthy products. Surprisingly, the profit from these products could have been

70% higher if there was no additional discount as the expiration date approached. Even if we consider additional costs from the no-discount policy (e.g., inventory cost), the profit increase is huge. Therefore, we can conclude that the excessive discount on nearly expired unhealthy products is not the best pricing strategy.

All in all, our findings imply that different pricing strategies should be used for products close to expiry depending on whether they are healthy or unhealthy. For healthy products, the conventional discount strategy for soon-to-be-expired products is valid. For unhealthy products, however, applying an additional discount on soon-to-be-expired products can harm profitability. These are crucial insights for practitioners who aim to maximize their profits when selling products close to expiry.

Communication Strategy: A Field Experiment

According to past research, heavy discounts on a product for no reason can hinder its sales (Haws and Bearden 2006; Xia, Monroe and Cox 2004), as the price generally signals product quality (Rao and Monroe 1989). In fact, customers may falsely believe that products with tacit heavy discounts have serious hidden defects and refuse to purchase it. For that reason, many retail stores (including the online retailer in Study 1) send a clear "soon-to-be-expired" message about products that are close to expiry by applying heavy discounts (Donselaar et al. 2006; Wang and Li 2012).

However, our findings imply that this strategy cannot be applied to different product categories in the same manner. The results of the two studies above imply that the sales of unhealthy products are unaffected by the time left until expiration. In other words, the sales of unhealthy products are minimally affected by the presence of a "soon-to-be-expired" message. In contrast, the two studies provide evidence that sales of healthy products decrease as they get

closer to their expiration dates. This finding implies that up front "soon-to-be-expired" messages on healthy products can harm profitability, and that sellers may need to find other marketing messages.

To test our conjecture that the message about product expiration may affect sales differently for products in different categories in a real-world setting, we conducted a field experiment with a 2 (type of product – healthy vs. unhealthy) × 2 (marketing message – "soon-to-be-expired sales" vs. "inventory clearance sales") design. In the experiment, we opened a pop-up store and sold products expiring in 30 days. The pop-up store was located next to the main gate of a private educational institute, so everyone visiting the institute was able to see it. The institute provides tutoring services for middle and high school students, and is located in Seoul, South Korea. The institute is a sizable one; roughly 1600 teenage students are enrolled, and the floating population per day is around 800. More specifically, students come to the institute following one of the four class schedules: i) 2-4pm every Mon/Wed, ii) 4-6pm every Mon/Wed, iii) 2-4pm every Tue/Thu, and iv) 4-6pm every Tue/Thu. According to the manager of the institute, there are roughly equal numbers of students (i.e., 400 students) registered for each study schedule, and no student is registered for more than one schedule.

The experiment was conducted over two days; we sold chocolate bars on the first day for the unhealthy product condition, and nutrition bars on the second day for the healthy product condition. To rule out intervention of the brand effect, we used chocolate and nutrition bars of the same store brand. The original prices of the chocolate and nutrition bars were almost identical (around \$0.70),[4] and the selling prices were set at \$0.20 for both products. As we sold the products at lower than regular prices, we did not allow subjects to purchase multiple

[4] More precisely, the price of a nutrition bar is \$0.75 and a chocolate bar is \$0.70, so the difference in price is negligible.

units to prevent stockpiling. On each day, we sold the products from 2pm to 6pm and switched the marketing message at 4pm; we posted a placard saying "inventory clearance sales" from 2pm to 4pm, then switched it to "soon-to-be-expired sales" from 4pm to 6pm. By having an experiment schedule consistent with the class periods, we prevented students from being exposed to both "inventory clearance" and "soon-to-be-expired" conditions.[5] Therefore, the number of students exposed to each condition was roughly the same, and no student was exposed to multiple messages.

The summary of sales in each condition is visualized in Figure 7. We sold 33 units of unhealthy products (i.e., chocolate bars) with the "inventory clearance" message and 31 units with the "soon-to-be-expired" message. In other words, the switch in marketing message did not result in a substantial change in sales. In contrast, the switch in marketing message made a surprising change in the sales of healthy products. We sold 72 units of healthy products (i.e., nutrition bars) with the "inventory clearance" message and only 19 units with the "soon-to-be-expired" message. That is, the sales of healthy products were almost quadrupled by using the alternative marketing message instead of "soon-to-be-expired" in our experiment. This finding emphasizes the importance of carefully managing marketing messages about healthy products when they are close to the expiration date. The results of a statistical test also confirmed that the effect of the marketing message significantly differed across the product categories (χ^2 = 12.45, df = 1, $p < .01$).

(Insert Figure 7 about here)

[5] It is an institute policy that all teenage students should be accompanied by authorized adults from and to the institute. Thus, students are not allowed to purchase products individually before or after a session. Thus, all the transactions were conducted during break time, so no student was exposed to both the "inventory clearance" and "soon-to-be-expired" conditions.

To summarize, the results imply that a practitioner who aims to sell healthy products close to the expiry date needs to manage the communication strategy carefully. We do not claim that practitioners should "hide" the information about the expiration date; if possible, however, they should avoid putting too much emphasis on "close-to-expiry" and try to find alternative wording such as "inventory clearance" to maximize their profits.

CONCLUSION

An expiration date denotes a predetermined date after which perishable products are no longer at their peak quality. In reality, the time left until expiry contains very little information about the quality of the product (Cosmos 2016; Donselaar et al. 2006; Sen and Block 2009; USDA 2016). However, extant research reported that customers frequently have misconceptions about the expiration date, falsely inferring the product quality from the time until expiry (Harcar and Karakaya 2005; Tsiros and Heilman 2005; Whitworth 2001). This tendency, herein labelled "expiration bias," has lowered the profitability of sellers who have difficulty in selling products that are near their expiration dates. Expiration bias has even caused economic and environmental problems, such as food wastage. Despite the importance of this issue, past research has examined expiration bias in fresh foods only; the findings of these studies may not be generalized to foods in other categories (Tsiros and Heilman 2005; Theotokis, Pramatari and Tsiros 2012). In this research, we broaden the scope of research in this area to different categories of products which serve different needs, investigating the nature of expiration bias.

Building upon extant literature, we note that the motivation behind food consumption is an important antecedent for expiration bias. Thus, we hypothesize that expiration bias in quality perception and sales is less severe for unhealthy products consumed to serve hedonic

needs than for healthy products consumed to meet health needs. Our hypotheses are consistently supported by the results of the econometric and experimental analyses; thus, we conclude that the effect of an approaching expiry date on perceptions of quality and sales are asymmetric between healthy and unhealthy foods because they are consumed to meet different needs.

Before discussing the practical value of these findings, we note that our paper contributes to the literature in two ways. First, we shed light on the nuanced nature of expiration bias. Past literature on expiration dates has documented evidence of expiration bias in a single food category (Tsiros and Heilman 2005; Theotokis, Pramatari and Tsiros 2012). In this paper, we extend the scope of such analyses, identify the psychological conditions underlying expiration bias, and show that expiration bias is at work only when health is a major motivation for food consumption. This research not only unveils the complex nature of the effect of the expiration date on sales, but it also pinpoints the conditions under which expiration bias is at work. Given the importance of this topic, future researchers may choose to examine other boundary conditions of the expiration effect based on different mechanisms. For instance, the effect of the expiration date on sales may be greater for products with a large-sized picture because consumers may be more concerned that they will not be able to eat it in time.

Second, our findings may be of interest to researchers who study differences between healthy and unhealthy products. Past studies have examined how the consumption of these two types of products is affected by different payment methods (Talukdar and Lindsey 2013; Thomas, Desai and Seenivasan 2011), marketing messages (Raghunathan, Naylor and Hoyer 2006), and price promotions (Bezawada and Pauwels 2013). Our findings add to this stream of research the concept of expiration bias as another interesting area of asymmetry between healthy and unhealthy products.

More importantly, we propose immediately actionable and profitable marketing strategies based on the findings of this study. Our paper has two take-away implications for managers. First, selective discounts on nearly expired products are advised. For healthy products, for which expiration bias may be severe, heavy discounts may be needed. However, for unhealthy products, for which expiration bias may be minimal, no heavy discount is needed. Sellers may preserve the profitability of nearly expired unhealthy products by avoiding unnecessary discounts; by doing so, they may enjoy a 70% increase in profit, as in our counterfactual simulation. Second, "soon-to-be-expired" may not be the best message to communicate to customers. Sellers need to think of alternative messages, especially when selling healthy products. In our field experiment, switching the marketing message from "near expiry" to "inventory clearance" led to an amazing result; the sales almost quadrupled!

Aside from managerial implications, our findings also have other marketing implications. For instance, sellers may consider selling products past the expiration date. Admittedly, it is an empirical question if doing so will be profitable or not; expiration bias may look totally different after the expiry date, and it may even harm seller's image in the long run. However, our findings thus far suggest that sellers should focus on unhealthy products if they want to sell products after the expiry date, as long as they do so at customers' own risk. In addition, sellers may want to encourage customers to purchase healthy products more on impulse and divert their attention from expiration dates to relieve expiration bias. For that purpose, time-delimited discounts, which are known to increase impulsivity during the purchase process (Aggarwal and Vaidyanathan 2005; Coulter and Roggeveen 2012; Kukar-Kinney, Scheinbaum and Schaefers 2016), on healthy products may boost sales. By enhancing profitability from sales of nearly expired products, wastage will be reduced and economic and environmental expenses will be minimized as well.

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Table 1. Descriptive Statistics and Correlations among Variables

Variables	Descriptive					Correlation		
	Mean	S.D	Median	Min	Max	*Sales*	*daysleft*	*discount*
sales	3.67	11.37	1.00	0.00	601			
daysleft	50.37	26.67	49.00	0.00	99	-0.11		
discount	2.14	6.61	0.00	-39.10	49.4	0.07	-0.23	
non-healthy**(dummy)**	0.81	0.39	1.00	0.00	1.00	0.00	0.05	-0.10

Notes: Our empirical model includes several additional covariates: time dummies (11 months, 6 weekdays) and product-specific fixed effects (1,031). These are not reported to avoid clutter.

Table 2. The Coefficient (Standard Error) of the Main Equation

	Coefficient	SE
daysleft($\hat{\beta}_1$)	.32**	(.07)
daysleft*unhealthy($\hat{\beta}_2$)	-.37**	(.09)
discount($\hat{\beta}_3$)	2.09**	(.51)
discount*unhealthy($\hat{\beta}_4$)	-2.84**	(.72)

Notes: The model includes several additional covariates: time dummies (11 months, 6 weekdays) and product dummies (1,031). These estimates are not reported to avoid clutter. The results of instrumental variable equation are provided in Appendix A. *$p < .05$; **$p < .01$.

Table 3. Summary of the Mediation Analysis

Independent variables	Perceived quality	WTP
Intercept	58.4** (12.34)	1.08** (.40)
Near expiry	-19.42** (5.15)	-.34* (.17)
Unhealthy products	-12.43* (5.18)	-.11 (.16)
Near expiry × Unhealthy products	14.28* (7.06)	.43 (.22)
Perceived quality		.005* (.002)

Notes: Standard error in parentheses. The model includes several additional covariates including health consciousness, self-control, planned purchase, snack consumption, and attitude to focal snack. These estimates are not reported to avoid clutter. *$p < .05$; **$p < .01$

Figure 1. Product Information on the Product List Page

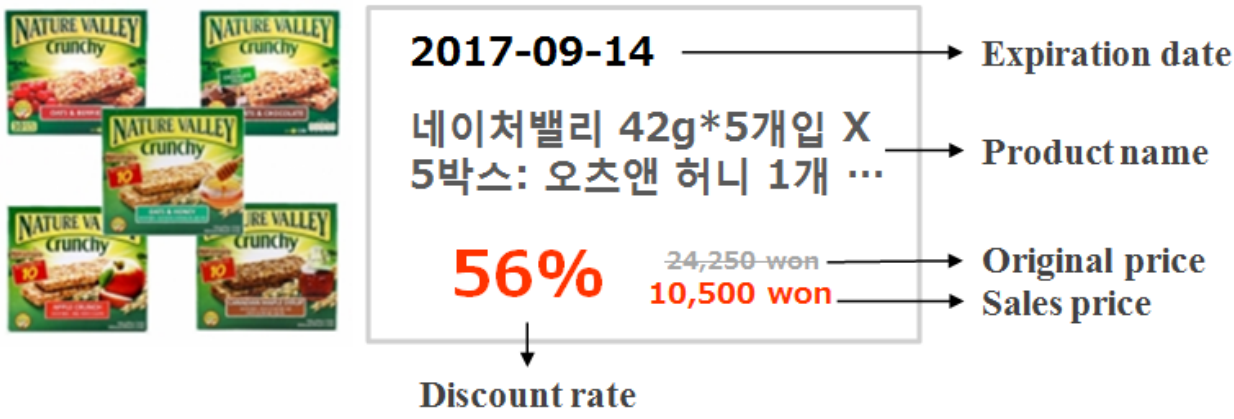


Figure 2. Average Daily Sales over Time: Healthy vs. Unhealthy

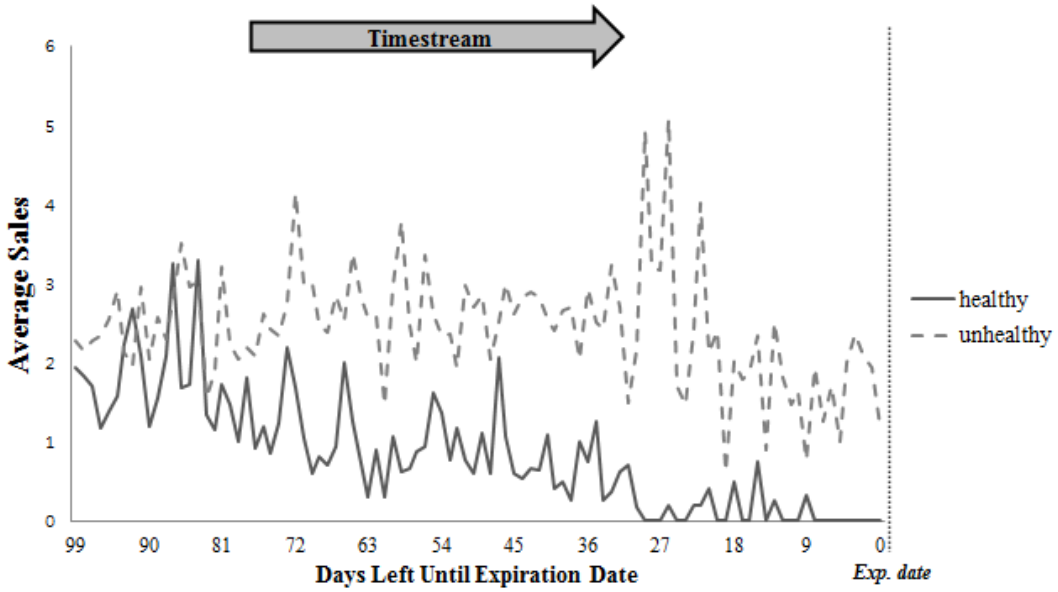


Figure 3. Contrasting Effects of Days until Expiry on Sales: Unhealthy vs. Healthy

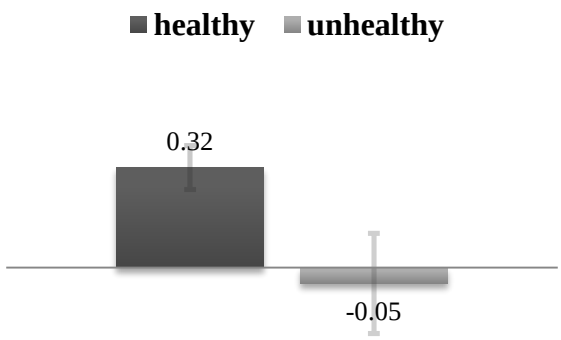


Figure 4. Screenshot of the Study

(a) Healthy-long condition

❖ ***100 days left to expiry***

- ***Today: Jul 3, 2017***
- ***Expiration date: Oct 10, 2017***

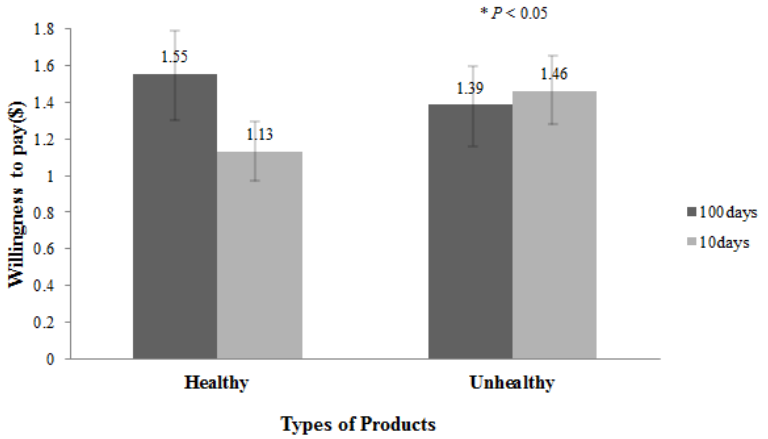
(b) Unhealthy-short condition

❖ ***10 days left to expiry***

- **Today: Jul 3, 2017**
- **Expiration date: Jul 12, 2017**

Figure 5. The Effect of Approaching Expiration Date: Healthy vs. Unhealthy

(a) Willingness to Pay ($)



(b) Perceived Quality of Products

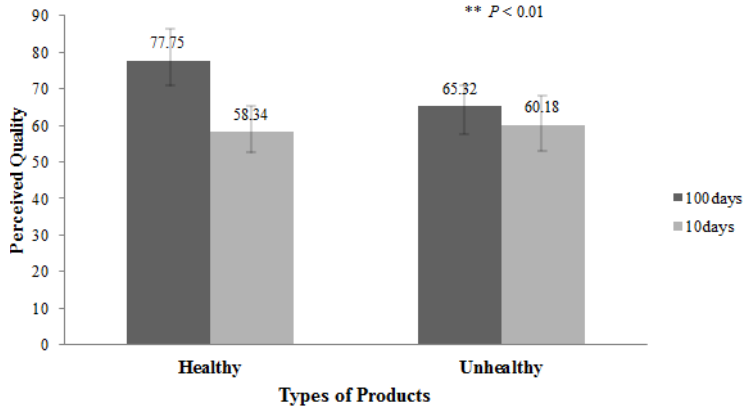


Figure 6. Model Framework: Moderated Mediation Process

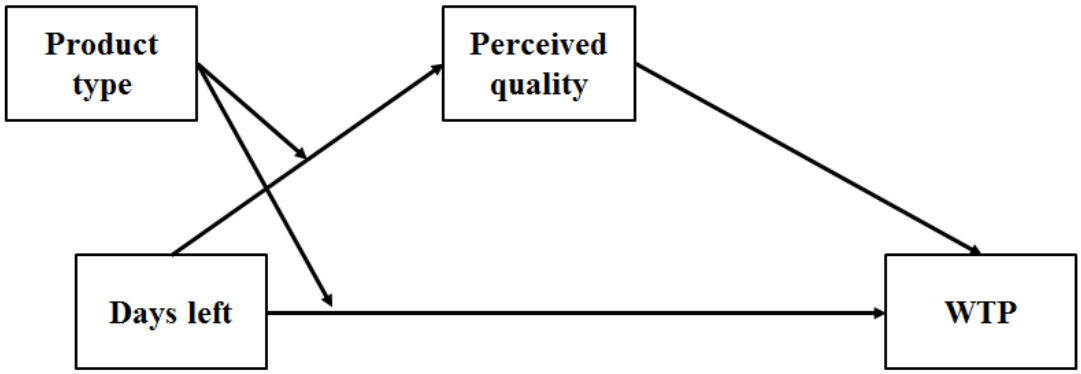
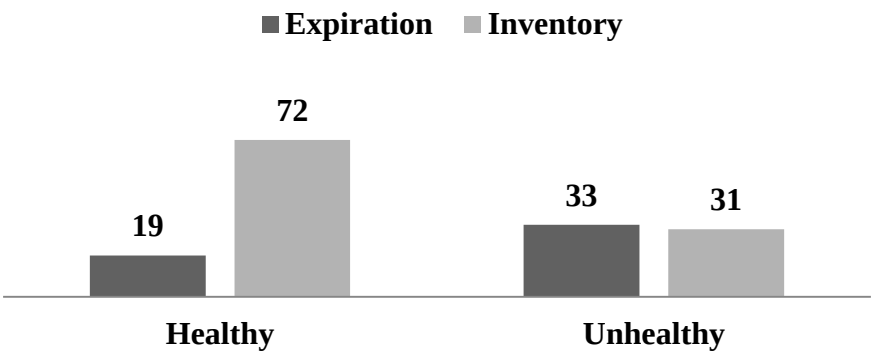


Figure 7. The Effect of Marketing Message on Healthy vs. Unhealthy Products



Appendix

Table A1. Results of the Instrumental Variables Equation

Dependent Variable: discount	Coefficient	SE
$margin_{t-1}(\tau_1)$	-.0000214**	.0000004
$profit_{t-1}(\tau_2)$	.0000006**	.0000000
$daysleft_t$	-.0014020**	.0000396
$daysleft_t$ *unhealthy	.0004927**	.0000333

Notes: The model includes several additional covariates: time dummies (11 months, 6 weekdays), product dummies (1,031) and key variables in main equation. These estimates are not reported to avoid clutter. *p < .05; **p < .01