



Coordinating supply-related scarcity appeals with online reviews

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Abstract

Online reviews play an important role in consumer purchase decisions and have received much research attention. However, previous research has typically examined the effects of online review characteristics independent of firm marketing messages. We argue that how much average review rating influences consumers' decisions depends on the presence of a scarcity appeal and its congruence with review volume information. Through a lab experiment and analyses of real-world data from Amazon.com, we show that claiming a product to have limited supply moves consumers toward more heuristic processing but only when review volume is consistent with the scarcity information. In contrast, when review volume is incongruent with the supply-based scarcity message, the incongruence prompts consumers to process information more carefully and reduces their reliance on review valence.

Keywords Online review · Review valence · Review volume · Scarcity appeal · Online retail

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1 Introduction

Prior studies have documented the impact of online reviews on firm performance metrics such as sales (e.g., You et al., 2015) and brand equity (e.g., Zhu & Zhang, 2010). Online reviews function as important quality signals in vertically differentiated markets, allowing consumers to compare and judge the quality of competing products. Although online reviews are important to firms, they also create a conundrum. Firms are more or less at the mercy of online reviews. After reviews are posted, firms are believed to have little control over how consumers may react to such reviews (Erskine, 2019). We challenge this traditional belief and suggest that firms can actively coordinate promotional information to influence consumers' processing of online reviews. Specifically, we examine whether the use of scarcity appeals, a common marketing tactic, can moderate the impact of online reviews on consumers' purchase decisions.

We focus on the use of supply-related scarcity (SRS) appeals (Ku et al., 2012), which happens when a firm limits the number of products available to the market. Examples of SRS appeals include statements such as “supplies are limited” and “while supplies last.” Typically, firms use SRS appeals to communicate value, quality, or exclusivity (Aguirre-Rodriguez, 2013). It is worth noting that this research does not examine the impact of demand-related scarcity (DRS), which is due to excessive demand for a product in the market. The main difference between SRS and DSR is that firms usually do not have much control over market-driven excessive demand. A recent example of DRS happened with the COVID-19 pandemic, with markets witnessing shortages of fast-moving consumer goods as a result of consumer panic buying.

Extending previous research, we argue that the presence of an SRS appeal moves consumers toward more heuristic processing, but only when the review volume level is consistent with the idea of the product being scarcely available. Such circumstances lead to an increased reliance on review valence as a mental shortcut. By contrast, when high review volume contradicts the scarce nature of the product, the incongruence activates persuasion knowledge (PK) (Friestad & Wight, 1994), prompts consumers to process information more carefully, and reduces their reliance on review valence.

Our study contributes to marketing research and practice in three ways. First, it highlights an opportunity to coordinate firm-generated marketing messages with consumer-generated content to achieve maximum effectiveness. Second, we enrich the scarcity literature by proposing a new role for scarcity appeals. Previous research in this area has predominantly focused on the direct effect of scarcity appeals on consumer attitude and decisions. The current research extends the reach of scarcity appeals and suggests considering the more comprehensive consumer decision-making environment when using such appeals. Third, research on scarcity appeals has frequently relied on lab experiments. We contribute to the literature by using real-world data from Amazon.com in addition to a lab experiment, thereby enhancing the generalizability of our findings.

2 Conceptual background

Prior research has demonstrated the importance of online reviews for both firm performance and consumer purchase decisions (e.g., Babić Rosario et al., 2016). Among the various components of online reviews, volume and valence have received the most attention. Review volume refers to the number of reviews available about a product. Research shows that a higher review volume leads to increased sales (e.g., Zhu & Zhang, 2010), as it signals the popularity of the product being reviewed (e.g., Zhang et al., 2014). Review volume further implies the reliability of the review information, as more people's opinions are considered (Salganik & Watts, 2008). Review valence refers to the average star rating or recommendation rate for the reviewed product. A positive review valence serves as a signal of high product quality (e.g., Purnawirawan et al., 2015) and can positively affect firms' financial performance and consumers' purchase decisions (e.g., Maslowska et al., 2017).

Although the positive effects of online review volume and valence are not surprising, previous research shows that there are important nuances in the impact of volume and valence on consumers. For example, the impact of online review volume on purchase intention is stronger for low-involvement consumers than for high-involvement consumers (Park et al., 2007). Review valence is more influential for experience products than for search products, for unfamiliar brands than for familiar brands (Purnawirawan et al., 2015), and for weak brands than for strong brands (Ho-Dac et al., 2013).

The moderating factors explored in previous research are often limited to elements that firms have little or no control over. In reality, online reviews are frequently presented together with the product's marketing messages (e.g., product information, price, availability). Thus, it is reasonable to expect that the two types of information can influence each other, which will allow firms to coordinate user-generated content and marketing tactics. We explore this possibility herein.

3 Scarcity appeals and online reviews

3.1 Scarcity appeals research

Scarcity appeals aim to create the perception that the demand for a product exceeds its supply and therefore access to the product is limited (Suri et al., 2007). This perception is often achieved by emphasizing either high demand for the product (DRS) or low supply of the product (SRS) (Ku et al., 2012). We focus on the latter type of appeals because of their more frequent use in the online retail environment.

Most studies on scarcity appeals have focused on contextual factors that affect the effectiveness of such appeals. For example, research indicates that the effect of scarcity appeals on purchase intention depends on the level of involvement with the product category (Das et al., 2018) and consumer expectations (Mukherjee

& Lee, 2016). More related to our research are previous findings suggesting that scarcity appeals can influence the way individuals process product information. Specifically, Suri et al. (2007) show that scarcity influences consumers' processing of price information. Aguirre-Rodriguez (2013) further proposes that scarcity appeals activate PK and subsequently affect persuasive outcomes.

3.2 Moderating effect of scarcity appeals and their congruence with review volume

Extending existing studies, we build on the heuristic-systematic model of information processing (Chaiken, 1980) and the PK literature to explain how scarcity appeals can affect online review effects. Review valence is a mental shortcut (heuristic) that consumers can use to make quick judgments about a product (e.g., Maslowska et al., 2017). In the presence of other available information such as product description or price, the degree to which consumers engage in heuristic processing is likely to affect the magnitude of the valence impact.

The heuristic-systematic model suggests that individuals are more likely to engage in heuristic processing when they view the heuristic information as sufficient for the decision at hand and when their motivation to process information is low (Chaiken, 1980). Other developments in the area show more specific conditions that drive information sufficiency judgment and motivation, one of which is the individual's state of arousal. In particular, the dynamic complexity model argues that arousal can reduce the cognitive complexity of perception and subsequently lead to more heuristic processing (Forgas, 1995; Paulhus & Lim, 1994). Thus, scarcity appeals can exert an impact, as they increase arousal and drive consumers to use readily available information in their decision-making (Suri et al., 2007). In turn, this can increase the potential impact of heuristic shortcuts such as review valence.

We argue that whether the presence of a scarcity appeal will indeed increase reliance on review valence depends on the congruence between review volume and the scarcity appeal. As marketer-supplied information, an SRS appeal is based on facts that are not readily accessible to consumers; therefore, judging the authenticity of such an appeal is difficult for them. When a scarcity appeal due to limited supply is presented alongside a large review volume, the former implies that the product cannot be sold widely, whereas the latter suggests that many consumers have purchased the product. Such discrepancy may alert consumers to a contradiction between the two sources of information, which in turn will activate consumers' PK and drive them to move from relying exclusively on mental shortcuts to more systematically processing all the information provided instead (Maheswaran & Chaiken, 1991). Indirect support for this tendency is provided by research findings showing that the presence of a scarcity appeal fails to affect consumer attitudes when consumers do not expect such a scarcity (Mukherjee & Lee, 2016). Along the same line, Shen (2016) finds that scarcity stops functioning as a heuristic cue when it is incongruent with the product message argument strength.

Taken together, this discussion suggests that how a scarcity appeal may influence the impact of review valence depends on review volume (Fig. 1). On the one hand,

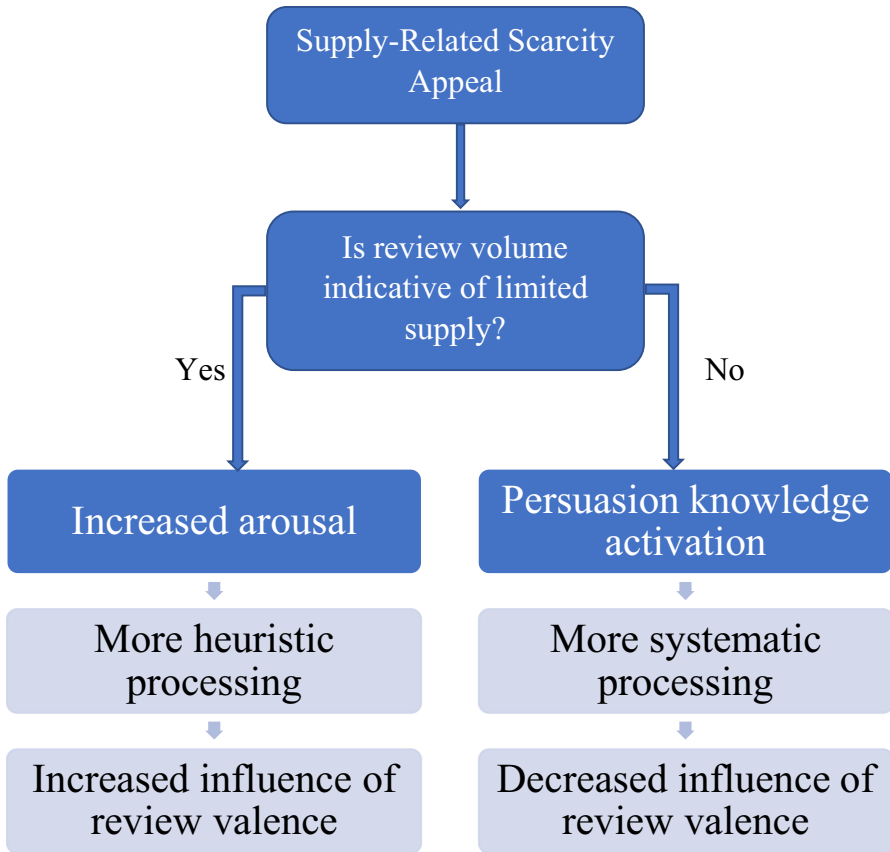


Fig. 1 Conceptual framework of scarcity appeal effects

the presence of a scarcity appeal can raise arousal and lead consumers toward more heuristic processing. In the absence of contracting evidence, the consequence is a stronger reliance on easy shortcuts such as review valence. On the other hand, if review volume is high, the contradiction between review volume and the scarcity appeal will activate PK, trigger more systematic processing, and reduce consumers' reliance on heuristic shortcuts such as review valence in their decision-making. Thus, we hypothesize the following:

H1: When review volume is high, the presence of a scarcity appeal weakens the effect of review valence.

H2: When review volume is low, the presence of a scarcity appeal strengthens the effect of review valence.

4 Study 1

4.1 Study design

We conducted an online experiment featuring a 2 (scarcity vs. no scarcity appeal) \times 2 (high vs. low review volume) \times 2 (positive vs. negative review valence) full-factorial between-subjects design. We collected 148 valid responses ($M_{\text{age}} = 32.39$, 55.41% female) from Amazon Mechanical Turk in exchange for monetary compensation. We used shoes from a fictitious brand as the focal product. Industry statistics show that Americans spend \$91 billion on shoes annually (Smith, 2022).

We randomly assigned participants to one of the eight conditions and told them to imagine that they were searching online for a new pair of running shoes and, in the process, were exposed to a simple advertising message for a (fictitious) shoe brand. The no scarcity appeal version of the advertising message read, “In collaboration with the renowned designer, Giovanni Esposito, we developed a new line of running shoes.” In the scarcity appeal version, a typical scarcity appeal appeared at the end of the ad message: “Only a very limited number of these shoes have been manufactured. So hurry up and grab yours before they’re all gone!”.

Following ad exposure, participants were directed to further information about the shoes. The subsequent review volume and valence information reflected the typical Amazon format (see Fig. 2) and varied depending on the experimental conditions. We used a pretest to determine the appropriate levels of online review volume and valence. The number of online reviews for the low and high conditions was 13 and 28, respectively. Furthermore, we used 4.5-star and 3-star (out of 5) ratings to represent positive and negative valence, respectively. An extremely negative review is likely to be rejected immediately without considering the other information available about the product.

In the next step, participants reported their attitudes toward the brand (adapted from Kirmani & Zhu, 2007). We averaged participants’ responses to the five 9-point items (unfavorable/favorable, unlikable/likable, not appealing/appealing, undesirable/desirable, and bad/good) to create their overall attitude ($\alpha = 0.98$). Finally, participants answered the manipulation check and demographic questions.

Negative Valence/Low Volume	Negative Valence/High Volume
 <p>3.0 out of 5 stars</p> <p>13 customer reviews</p>	 <p>3.0 out of 5 stars</p> <p>128 customer reviews</p>
Positive Valence/Low Volume	Positive Valence/High Volume
 <p>4.5 out of 5 stars</p> <p>13 customer reviews</p>	 <p>4.5 out of 5 stars</p> <p>128 customer reviews</p>

Fig. 2 Study 1 review information

4.2 Manipulation check

To check the scarcity appeal manipulation, we asked participants how much they agreed or disagreed with the statement that “there was a limited supply of the running shoes that were advertised” (1 = “strongly disagree,” 7 = “strongly agree”). The mean ratings suggested a successful manipulation ($M_{\text{no scarcity}} = 2.09$ vs. $M_{\text{scarcity}} = 6.38$; $t = 19.58$, $p < 0.001$).

We checked the review volume manipulation with two 9-point items that asked participants the extent to which they perceived the number of online reviews for the product as low (1)/high (9) and as “much lower than what I expected” (1)/ “much higher than what I expected” (9). The average of these two items ($r = 0.77$) differed significantly between the low- and high-volume conditions ($M_{\text{low-volume}} = 3.07$ vs. $M_{\text{high-volume}} = 6.01$; $t = 9.76$, $p < 0.001$). We followed the same procedure for review valence. The average of the two items ($r = 0.86$) was 7.73 for the positive valence condition, significantly more positive than the mean of 3.39 for the negative valence condition ($t = 22.06$, $p < 0.001$). Overall, all manipulations appeared to be successful.

4.3 Hypotheses testing

We ran a three-way ANOVA with attitude toward the brand as the dependent variable and scarcity, volume, valence, and their interactions as the independent variables. Confirming H1 and H2, the analysis revealed a significant three-way interaction ($F(1, 140) = 5.16$, $p = 0.025$, partial $\eta^2 = 0.04$), in addition to a significant main effect of volume ($F(1, 140) = 4.38$, $p = 0.038$, partial $\eta^2 = 0.03$) and a significant main effect of valence ($F(1, 140) = 63.53$, $p < 0.001$, partial $\eta^2 = 0.31$).

To help interpret the interactions, we conducted a separate two-way ANOVA for each of the two review volume conditions. The results from

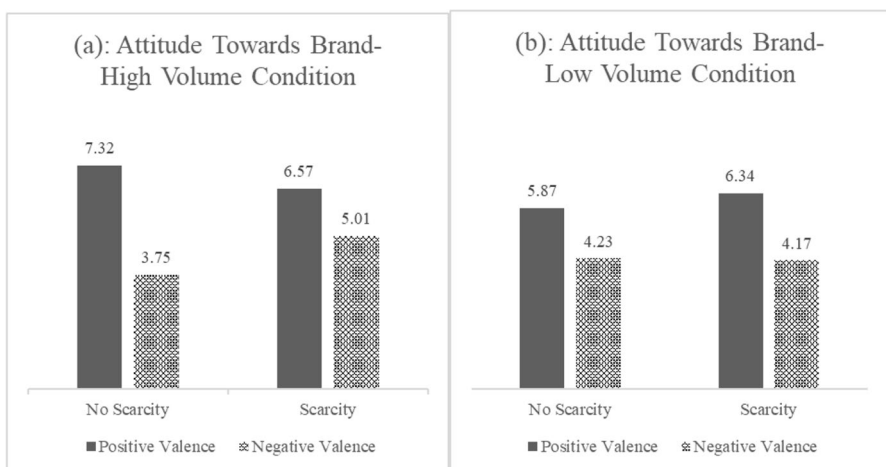


Fig. 3 Study 1 mean attitude toward brand. **a** Attitude toward brand—high-volume condition. **b** Attitude toward brand—low-volume condition

the high-volume analysis showed a significant main effect of valence ($F(1, 71) = 41.08$, $p < 0.001$, partial $\eta^2 = 0.37$) and a significant two-way interaction between valence and scarcity ($F(1, 71) = 6.62$, $p = 0.012$, partial $\eta^2 = 0.09$). As panel a of Fig. 3 shows, when the no scarcity appeal was present, positive valence led to significantly more positive attitudes than negative valence ($M_{\text{high-volume, no-scarcity, positive}} = 7.32$ vs. $M_{\text{high-volume, no-scarcity, negative}} = 3.75$; $t = 6.25$, $p < 0.001$). By contrast, when the scarcity appeal was present, the gap between the positive and negative valence conditions was still significant but much smaller in magnitude ($M_{\text{high-volume, scarcity, positive}} = 6.57$ vs. $M_{\text{high-volume, scarcity, negative}} = 5.01$; $t = 2.94$, $p = 0.005$). In support of H1, the presence of a scarcity appeal diluted the effect of review valence when review volume was high.

Panel b of Fig. 3 shows the mean attitude scores for the low-volume conditions. Although the pattern of results is in the hypothesized direction, showing a larger valence effect under scarcity than under no scarcity, the difference was not significantly different, as indicated by a non-significant two-way interaction between valence and scarcity ($F(1, 68) = 0.46$, $p = 0.498$, partial $\eta^2 = 0.006$). The two-way ANOVA revealed only a significant main effect of valence ($F(1, 68) = 23.56$, $p < 0.001$, partial $\eta^2 = 0.25$). Valence had a similarly positive effect on attitude when the scarcity appeal was absent ($M_{\text{low-volume, no-scarcity, positive}} = 5.87$ vs. $M_{\text{low-volume, no-scarcity, negative}} = 4.23$; $t = 2.82$, $p = 0.006$) than when it was present ($M_{\text{low-volume, scarcity, positive}} = 6.34$ vs. $M_{\text{low-volume, scarcity, negative}} = 4.17$; $t = 4.00$, $p < 0.001$). Therefore, H2 was not supported.

4.4 Discussion

Study 1 shows that the presence of an SRS appeal can affect the extent to which review valence influences consumers. The results show the detrimental effect of a scarcity appeal under high review volume, as hypothesized in H1, but not the beneficial effect of scarcity under low review volume (H2). The effect size of the scarcity \times valence interaction was much smaller under low volume than under high volume. This disparity in effects may be partly due to the specific levels of review volume used. Having 13 reviews for a scarce product may not have been considered low by at least some of the participants, thus weakening the effect in that condition. We address this issue in study 2 using real-world data and a different product category, in which a full range of review volume can be observed.

5 Study 2

Study 1 has several limitations that need to be addressed. First, it examined attitude as the outcome variable, which may or may not translate into actual purchase decisions. Second, the low-involvement nature of a hypothetical scenario may have masked the potential effect of the scarcity appeal in the low-volume

conditions. Finally, we provided only review volume and valence information without actual reviews or product information. The scarcity appeal was also provided separately as an ad message. Thus, it could be argued that such a design does not reflect the typical online retail setting and may have created a demand effect. To address these limitations, study 2 uses real-world data collected from Amazon to test the research hypotheses.

5.1 Data and method

We chose fertilizers (for lawn and plants) as the product category in study 2 for generalizability purposes. Whereas shoe purchases are driven considerably by idiosyncratic and subjective taste, fertilizers are usually evaluated on their objective performance. Therefore, other consumers' reviews of a fertilizer's effectiveness may be even more important in decision-making. We collected information on 443 randomly selected fertilizer products sold on Amazon. To be selected, a product had to have at least one consumer review. Following Chevalier and Mayzlin (2006), we collected data at three different times over a 45-day period: day 1 (t_1), day 31 (t_2), and day 45 (t_3). This represents a shorter time window than previous research due to much higher sales and review activities and correspondingly more frequent updates of sales ranking on Amazon. We collected the data between April and June, a highly active period for the product category.

Although Amazon does not provide actual product sales, it publicly displays the rankings of millions of items in each product category based on their sales performance using a proprietary formula. Previous research shows that the logarithm of this sales rank has a linear relationship to product sales (Chevalier & Mayzlin, 2006; Ho-Dac et al., 2013). Therefore, we used log-transformed sales rank as our dependent variable. As the numeric sales rank is higher for products with lower sales, we multiplied the log-transformed sales rank by -1 for ease of interpretation, which is equivalent to $\ln(1/SalesRank)$ (Ho-Dac et al., 2013). We model this negative log-transformed sales rank as:

$$\begin{aligned} \ln\left(\frac{1}{SalesRank_{i(t+1)}}\right) &= \beta_0 + \beta_1 Valence_{it} + \beta_2 \ln(Volume_{it}) + \beta_3 Scarcity_{it} \\ &+ \beta_4 Valence_{it} * \ln(Volume_{it}) + \beta_5 Valence_{it} * Scarcity_{it} + \beta_6 \ln(Volume_{it}) \\ &* Scarcity_{it} + \beta_7 \ln(Volume_{it}) * Valence_{it} * Scarcity_{it} + \ln\left(\frac{1}{SalesRank_{it}}\right) \quad (1) \\ &+ \sum_{k=1}^5 \gamma_k X_{it,k} + u_i + \varepsilon_{i(t+1)} \end{aligned}$$

where $SalesRank_{i(t+1)}$, the sales rank for product i at time $t + 1$, is a function of the independent variables from the previous time point t ; $Valence_{it}$ is the mean-centered average star rating for product i ; $Volume_{it}$ is the number of reviews for product i , which is log-transformed due to skewness and then mean-centered to facilitate the interpretation of results; $Scarcity_i$ is a dummy variable indicating

whether product i uses a supply-based scarcity appeal or not ($1 = \text{yes}$; $0 = \text{no}$), as coded from the product's information page; $SalesRank_{it}$ is the product's sales rank from the previous time point t , to allow for the carryover effect of a product's sales rank over time; $X_{it,1}, X_{it,2}, \dots, X_{it,5}$ represent five time-varying control variables, including product price, product title length, product description length, expected shipping delay ($1 = \text{yes}$; $0 = \text{low}$), and log-transformed number of user questions; u_i is the fixed effect for product i to capture time-constant product characteristics, many of which are unobserved (e.g., innate quality, brand equity); and $\varepsilon_{i(t+1)}$ is the model error. To estimate the model, we used differencing between two adjacent periods ($t_3 - t_2$ for the dependent variable and $t_2 - t_1$ for the independent variables) to eliminate the unknown product-specific effect u_i . This left us with a cross-sectional model estimated using ordinary least squares (Wooldridge, 2002).

5.2 Results

Table 1 shows the descriptive statistics of the products at each of the three time points. A preliminary examination of the data uncovered three particulars. First, the average star ratings were quite high among the products, similar to previous studies using Amazon data (e.g., Ho-Dac et al., 2013). Second, SRS appeals were quite common in this product category on Amazon, used by more than one-third of the products at any given point in time. Third, sales rank showed significant changes over time, suggesting that the time window we chose was sufficient to capture sales dynamics.

With regard to the estimation results from our proposed model, the R -square for the model was 21.36%. The results showed a significant and positive two-way interaction between volume and scarcity ($\beta_6 = 0.52$, $p = 0.02$), a significant and positive interaction between valence and scarcity ($\beta_5 = 0.80$, $p = 0.05$), and a significant and negative three-way interaction among valence, volume, and scarcity ($\beta_7 = -1.33$, $p = 0.03$). To interpret the three-way interaction, we examined

Table 1 Study 2 product characteristics

	Day 1	Day 31	Day 45
Average star rating	4.43	4.42	4.43
Average review volume per product	24.99	26.39	27.77
% with scarcity appeal	37.70%	39.28%	39.95%
Average sales rank	84,676	93,479	99,773
Average price	\$30.94	\$30.56	\$30.28
Average title length	8.56 words	8.53 words	8.53 words
Average description length	53.37 words	52.34 words	52.38 words
% with delayed shipping	3.16%	2.94%	4.29%
Number of user-questions per product	6.71	3.05	3.24

Each column reflects the cumulative statistics of the variables in the three specific days that we collected data

the simple slope of the valence and scarcity interaction term across different levels of review volume (Spiller et al., 2013). When the mean-centered log-transformed review volume was at or above 3.61 (i.e., raw volume > 335.29), there was a significant, negative interaction between valence and scarcity appeal. By contrast, when the mean-centered log-transformed volume was below 0.02 (i.e., raw volume < 9.25), there was a significant, positive interaction between valence and scarcity appeal. Between those two volume thresholds, the valence \times scarcity interaction was not significant. These results provide support for our research hypotheses; a scarcity appeal reduced the effect of valence when review volume was high (H1) but strengthened the effect of valence when review volume was low (H2). Overall, our hypotheses were supported. Among the control variables in the model, only the log-transformed number of user questions had a significant effect ($\gamma_5 = -0.09$, $p < 0.001$).

6 Discussion

6.1 Theoretical contributions

Although research has extensively studied the impact of online reviews on firm performance and consumer purchase decision-making (e.g., You et al., 2015), exploration of how a firm can use its marketing actions to effectively coordinate online review effects is missing. Our findings show that the presence of an SRS appeal can influence the extent to which consumers consider review valence in their evaluation and purchase decisions of a product and that this effect is contingent on the consistency between the scarcity appeal message and review volume.

This research makes several contributions to marketing theory. First, it suggests that how consumer reviews affect readers depends not only on the reviews themselves but also on the information environment, including firm-generated information. Second, our findings contribute to research on cue interaction in consumer learning and decision-making. Prior research suggests that multiple cues in an information acquisition and decision environment can interact with one another, sometimes creating an additive effect and sometimes competing with each other (Van Osselaer 2008). We extend this line of research by demonstrating how two cues in an online retail environment (scarcity appeal and review volume) can work together to determine the effect of a third cue (review valence). Third, we also contribute to the literature on managing brands in the social media environment. In a review of branding theories, Allen et al. (2008) argue that consumers, firms, and culture are all co-producers of brand meaning. Our findings lend support to the argument that consumers take into consideration both firm and other users' influences simultaneously.

6.2 Managerial implications

Our research offers important implications for marketers. A key finding is that a retailer's marketing messages can effectively influence how consumers react to user-generated content, despite the retailer's lack of control over such content. We specifically propose the use of scarcity appeals as one such message. In reality, retailers often deal with product scarcity situations. Our research suggests an opportunity to leverage such situations by deciding whether and how to communicate the scarcity to consumers. As scarcity by definition involves an imbalance between supply and demand, it can be presented as either a supply shortage or an over-demand. The appropriateness of either may depend on the nature of online reviews available for the product.

Our research also has implications for the common practice of soliciting consumer reviews. Our findings imply that this may not be a wise practice to follow if the product is in limited supply and is expected to frequently feature a scarcity appeal. More broadly, firms need to carefully consider user-generated content about their products or business when designing marketing messages. An obvious inconsistency between firm-supplied information and user-generated content can create dissonance and activate consumers' PK (e.g., Aguirre-Rodriguez, 2013).

6.3 Limitations and future research

This research has several limitations that need to be addressed in future research. First, we consider SRS (i.e., under-supply) in our research, but sometimes scarcity can also be caused by excessive demand. Future research could investigate whether online reviews work differently with DRS versus SRS. Second, we examined two product categories, shoes and fertilizers, that are moderately involving and have vertically differentiated products. The dynamics of online reviews and their interaction with scarcity can be quite different for horizontally differentiated products or at more extreme ends of the involvement continuum. Future research could test the generalizability of our findings in these other contexts. Third, study 1 used a lab experiment with scenarios that may not fully reflect the reality of online retailing; some of the effect sizes in the study were also small (Cohen, 1992). Further research using real-world data as we did in study 2 is thus warranted. Finally, future research could also examine the interaction between other types of marketing tactics and consumer reviews, as inconsistencies can be caused by different factors. For example, a "hand-crafted, best-quality" product claim may contrast with a mediocre or even negative average consumer rating.

All authors are in full compliance with ethical standards and professional conduct. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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