User-Generated Content and Product Design of Competing Firms

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Abstract

User-generated content has been ubiquitous on the Internet. This paper studies the effect of user-generated content on competing firms' product design decisions when they face uncertain consumer taste. User-generated content makes firms better informed about consumer taste because of the additional information revealed, and it also makes their information more correlated because user-generated content is common and accessible by all firms. We build a game theoretical model in which two competing firms design and sell horizontally differentiated products to a group of consumers with unknown taste. Each firm observes a signal regarding consumer taste. We find that the variance-reducing effect embedded in user-generated content hurts the firms, and the correlation-increasing effect benefits the firms. The former is because uncertainty in the consumer taste makes firms unsure about where the demand is and thus can soften the competition between them. The reduced uncertainty by user-generated content intensifies the competition. The latter is because more correlated information can reduce the instances in which intended differentiation realizes similar product designs because the blindness of each other's information, and thus more correlated information can help the firms better "coordinate" their product positioning. Whether firms lose or benefit because of user-generated content depends on the interaction between the two

effects. When the correlation-increasing effect dominates, the firms benefit from the user-generated content. In this case, the expected product differentiation is larger, the expected prices are higher, but consumer surplus is lower. When the two effects are comparable, a "win-win" result might arise in which both firms and consumers benefit from user-generated content.

Keywords: User-Generated Content; Product Design; Competition;

1 Introduction

The rise of Web 2.0 and social media has ushered in a new era of content generation, where information can be easily created by users and accessed by different parts including manufacturers. A large number of applications have emerged that facilitate content generation. Examples include blogs, online product reviews, and online crowdsourcing platforms such as Dell's IdeaStorm.com. The theme of the whole Web 2.0 landscape has been the "two-way" communication: in addition to users' receiving message from firms, firms are listening to users more than before. For example, on IdeaStorm.com, there have been "over 18,971 ideas submitted" and Dell has made "535+ ideas implemented" since its launch in 2007.[1] This paper studies the effect of user-generated content on competing firms' product design decisions when they face uncertain consumer taste.

With the help of different Web 2.0 applications, user-generated content has been fast-growing and has become a significant part of the online world. Users discuss and comment on current products or services, and also express their wish in new products for the future. In addition, many firms now follow users' conversation on the Internet, listen to their opinions, and try to incorporate users' ideas to their business. For example, many firms (e.g., Nike) have their Facebook company pages to listen to and interact with their fans. Firms (e.g., Southwest Airline) have also been following the discussion across different social media platforms such as Twitter. More directly, in the past few years firms launched different

[1] http://www.ideastorm.com/idea2AboutIdeaStorm?v=1365388980625

crowdsourcing platforms to seek for consumer input, ideas, and advice on how to improve their products or services. Examples include Dell's IdeaStorm, Starbucks' myStarbucksIdea, Salesforce's customer community, and BestBuy's Idea Exchange. Starbucks founded the open environment, myStarbucksIdea, to hear consumers' ideas for the new product development in 2008 and several recent Starbucks products, such as Mocha Coconut Frappuccino, are the examples.[2] Starbucks also collects consumer insights on Facebook, which accumulates massive amount of information about consumer preference.[3] Evidently, many firms listen to online users and are interested in getting ideas from user-generated content for their business, including their product design.

Traditionally, product design is done as an in-house process. Firms conduct their private market research and based on their experiences and the information collected about consumers, they position their products. Because the product design decisions affect their long-term market performance, firms typically spend a considerable resource on market research. Recently, with the rise of user-generated content, the product design is more like an open innovation process. Firms in different industries use the online crowds for their product design to different extents. The least common component is that firms have access to user-generated content and can incorporate the information revealed by user-generated content into their product design. On the one hand, the massive amount of user-generated content provides more information about what consumers really want, and thus it makes firms better informed about consumer taste. On the other hand, user-generated content makes firms' information about consumer taste more correlated, because user-generated content is common and accessible by all firms.

We build a game theoretical model to study the effect of user-generated content on competing firms' product design. In particular, we consider that two firms design and sell horizontally differentiated products to a group of consumers with unknown taste. Each firm observes a private signal regarding consumer taste. User-generated content makes their

[2]http://news.starbucks.com/article_display.cfm?article_id=764
[3]http://extension.missouri.edu/explorepdf/agguides/hort/g06229.pdf

signal more accurate and more correlated, compared to the traditional case without the user-generated content. We consider a two-stage "location-then-price" game. In the first stage, firms choose to position their products, without knowing the true consumer taste. In the second stage, after observing the consumer taste, the firms price their products. We consider the two effects embedded in user-generated content, variance-reducing effect and correlation-increasing effect, and examine the effect of the online user-generated content on the firms' product design decisions, prices, and their profits, as well as consumer surplus and social welfare.

We find that the variance-reducing effect embedded in user-generated content hurts the firms, and the correlation-increasing effect benefits the firms. The former is because uncertainty in the consumer taste makes firms unsure about where the demand is and thus can soften the competition between them. The reduced uncertainty by user-generated content intensifies the competition. The latter is because more correlated information can reduce the instances in which intended differentiation realizes similar product designs because the blindness of each other's information, and thus more correlated information can help the firms better "coordinate" their product positioning. Whether firms lose or benefit because of user-generated content depends on the interaction between the two effects. When the correlation-increasing effect dominates, the firms benefit from the user-generated content. In this case, the expected product differentiation is larger, the expected prices are higher, but consumer surplus is lower. When the two effects are comparable, a "win-win" result might arise in which both the firms and consumers benefit from user-generated content. The real benefit brought by user-generated content is realized in social welfare: in the presence of user-generated content, social welfare is always higher.

Researchers have shown the significant effect of user-generated content on the consumers decision (Deloitte and Touche, 2008; Cone, 2010) and on the product sales and market performance (Forman et al., 2008; Archak et al., 2011). Others also study on how to extract product features from user-generated content (Hu and Liu, 2004; Ghani et al., 2006). In particular, Archak et al. (2011) identify the weight that consumers put on different product

features in evaluating a product by mining text reviews online. However, little attention has been paid to studying the effect of user-generated content on product design decision, although the marketers and managers often use social media to generate ideas for the new product design (Sullivan, 2010; Bayus, 2013; Jeff, 2008). Our research contributes to the literature by analyzing the effect of online user-generated content on firms' decisions of product design.

Our research is related to the product differentiation and product design, and in particular, to the product differentiation under demand uncertainty. Research has found that the uncertainty about the aggregate level demand could be one driving force of product differentiation (Meaghera and Zauner, 2004), while uncertainty decreases the differentiation under the individual level uncertainty (Palma et al., 1985). Apart from these studies, we model each firm's private information regarding the uncertain demand and the effect of user-generated content on the information each firm receives, and examine the effect of user-generated content on firms' product design decision and the profits. We analyze the firms' competition in both prices and product design when firms face not only demand uncertainty but the competitor's decision, while the existing literature mostly models the sequential entry of sellers with private knowledge, in which the entrant observes the incumbent's product offering, and assumes exogenous price (Jovanovic, 1981; Bonein and Turolla, 2009).

Considering the new product development practice in business, Raju and Roy (2000) examine the firms' price competition and industry characteristics, assuming each firm's asymmetric precision on forecasting the unknown industry demand size. Lauga and Ofek (2009) analyze the firms' incentives for costly market research and R&D effort on deciding the new feature to develop and the technical efforts level to innovate it. Different from them, we examine the effect of user-generated content which is common to all firms and is free. We show that this increased commonality because of the consumers' opinion given to both firms benefits firms by making the firms better conjecture the competitor's decision while reduction in uncertainty hurts firms by making firms less differentiated.

The rest of this paper is organized as follows. In the next section, we lay out the model.

In Section 3, we derive the main results of the effect of user-generated content on the firms' product design decisions and their profits. Section 4 concludes the paper.

2 Model

We consider two firms, each selling one product. The products are imperfect substitutes, and the two firms compete with each other. We call the firm that sells product i firm i, $i \in \{1, 2\}$. The marginal production cost for each product is assumed to be zero.

Consumer Utility and Demand: We assume that consumers have different preferences over the two products. We use Hotelling's horizontal differentiation framework to capture consumer preference. Consumers are uniformly distributed along the line $[M - \frac{1}{2}, M + \frac{1}{2}]$. Product i is located at x_i. The distance between a consumer and a product measures the degree of misfit of the product to the consumer: the longer the distance, the greater the degree of misft. We denote V as the surplus enjoyed by each consumer when he consumes an ideal product with perfect fit. In general, the products have some degrees of misfit to the consumers. For the consumer located at x, we assume that the misfit cost is $t(x - x_i)^2$ when consuming product i. Denoting the price as p_i, we can formulate the utility of the consumer located at x from consuming product i as follows:

$$U_i = V - t(x - x_i)^2 - p_i$$

Based on this formulation, we find the indifferent consumer to be located at $\xi = \frac{p_2 - p_1 + (x_2^2 - x_1^2)t}{2(x_2 - x_1)t}$ who derive the same utility from consuming either product and thus is indifferent between purchasing product 1 or 2.

We assume that each consumer has a unit demand. If we assume $x_1 < x_2$ and $\xi \in [M - \frac{1}{2}, M + \frac{1}{2}]$, we can formulate the demand for each product as

$$\begin{aligned} D_1 &= \tfrac{1}{2} + (\xi - M) \\ D_2 &= \tfrac{1}{2} - (\xi - M) \end{aligned} \tag{1}$$

We also assume that the surplus V is large, relative to the misfit costs and price, such that the market is fully covered.

Demand Uncertainty and User-Generated Content: Different from the standard horizontal differentiation models, firms are uncertain about the consumer space, M. Traditionally (in the absence of user-generated content), firms conduct their own market research regarding the demand before their product design decisions. We model the information that a firm has about the consumer space as the firm observes a signal regarding M. User-generated content provides additional and public information for both firms. In the presence of user-generated content, first, each firm has a better understanding of the consumer space because of the additional information revealed by user-generated content, and thus the signal each firm receives has a better precision. Second, because this information revealed is public and common to both firms, user-generated content increases the correlation between the two firms' signals. Formally, we assume that firm i observes a signal s_i, with mean M and variance σ^2, where M is a unknown constant. We assume that two signals are jointly normal, as commonly used in the literature (Vives, 1984; Raju and Roy, 2000). In the absence of user-generated content, we assume the two signals are independent and each is with variance σ^2_{wo} . In the presence of user-generated content, the variance for each is σ^2_w, $\sigma^2_w < \sigma^2_{wo}$, and the correlation coefficient between them is ρ, $\rho \geq 0$. Technically, we assume that $\sigma^2 \leq \frac{18-3\sqrt{36-2(1+\rho)}}{2(1+\rho)}$ such that in equilibrium $x_1 < x_2$ and $\xi \in [M - \frac{1}{2}, M + \frac{1}{2}]$.

Timing of the Game: The sequence of events is as follows. In stage 1, the firms determine the positions of their products x_i, based on the information they have about consumer space. In stage 2, the demand uncertainty is resolved, and then the firms set prices p_i simultaneously. Essentially, we assume that, after observing the demand, firms can respond to the market by changing prices, but not product design. We assume this order because product design is a long-term decision and pricing could be rather short term. Also, changing product design is more costly than changing price. In stage 3, consumers make their purchase decisions and demand is realized. We consider two scenarios: one without user-generated content and the other with user-generated content. We use the first scenario as the

benchmark to analyze the effect of user-generated content on the product design decision. Firms' own signals about demand and consumers' misfits are their private information. All other model parameters are common knowledge. All players are risk neutral.

3 Effect of User Generated Content on Product Design

In this section, we first derive the Bayesian Nash equilibrium, following the approach of backward induction. We then analyze the effects of user-generated content on the competing firms' product design decisions and payoffs, by comparing their equilibrium outcome with those without user-generated content. (Because of the page limit, the derivation of the equilibrium payoffs and all proofs are omitted and are available upon request.)

In stage 2 of the game, after observing the consumer space, the firms maximize their profits by choosing the optimal prices for their products; that is,

$$\max_{p_i} \pi_i = p_i D_i,\ i \in \{1, 2\} \tag{2}$$

By the first-order conditions, we derive the firms' optimal prices, which are functions of the product design choices x_i:

$$\begin{aligned} p_1 &= \tfrac{2t}{3}(x_2 - x_1)\left[\tfrac{3}{2} + (\tfrac{x_1+x_2}{2} - M)\right] \\ p_2 &= \tfrac{2t}{3}(x_2 - x_1)\left[\tfrac{3}{2} - (\tfrac{x_1+x_2}{2} - M)\right] \end{aligned} \tag{3}$$

Substituting the optimal prices to the firms' profit functions, we obtain the firms' profit as functions of the location choices x_i and M:

$$\begin{aligned} \pi_1 &= \tfrac{t}{18}(x_2 - x_1)(3 - 2M + x_1 + x_2)^2 \\ \pi_2 &= \tfrac{t}{18}(x_2 - x_1)(3 + 2M - x_1 - x_2)^2 \end{aligned} \tag{4}$$

In stage 1 of the game, the firms do not know M and face uncertainty regarding the demand. Firm i observes his own private signal about consumer space, s_i, but does not

observe his competitor's signal. We conjecture that each firm's equilibrium product design strategy is to choose a location linear in his signal regarding M; that is, $x_i = s_i + b_i$, where b_i is a constant to be determined. The conjecture of the linearity has been proved to be effective in the literature (Vives, 1984; Li, 2002). Based on this conjecture, we next derive the firms' optimal product design strategies and verify such a conjecture is correct.

Using this conjecture of each firm's product design, a firm's profit can be rewritten as his own location decision x_i and the signal that his competitor receives s_j

$$\begin{aligned} \pi_1 &= \tfrac{t}{18}(b_2 + s_2 - x_1)(3 - 2M + b_2 + s_2 + x_1)^2 \\ \pi_2 &= \tfrac{t}{18}(x_2 - b_1 - s_1)(3 + 2M - b_1 - s_1 - x_2)^2 \end{aligned} \tag{5}$$

Notice that in addition to M being unknown, firm i's competitor's signal s_j is also unknown to firm i. Given the two signals following a jointly normal distribution, $s_j|s_i$ follows a normal distribution with mean $[(1-\rho)M + \rho s_i]$ and variance $(1-\rho^2)\sigma^2$. Hence, we can derive firm i's expected profit, given his own signal s_i, by taking the expectation with respect to the conditional distribution of s_j. Firms maximize their expected profits by choosing their optimal product locations, given his own signal s_i; that is,

$$\max_{x_i} \mathbb{E}(x_i|s_i) = p_i D_i,\ i \in \{1, 2\} \tag{6}$$

By the first-order conditions, we derive firm i's optimal location choice, which is a function of b_j, $j = 3 - i$. Combining that with the conjecture of the linearity, we can derive b_i, and given his signal s_i we can formulate firm i's optimal location choice x_i^* as:

$$\begin{aligned} x_1 &= s_1 - \tfrac{3}{4} - (1+\rho)\tfrac{\sigma^2}{6} \\ x_2 &= s_2 + \tfrac{3}{4} + (1+\rho)\tfrac{\sigma^2}{6} \end{aligned} \tag{7}$$

Substituting the firms' optimal locations back to their prices (3) and profits (4), we can

derive the equilibrium prices and profits as follows.

$$\begin{aligned} p_1 &= \tfrac{t}{18}(3 - 2M + s_1 + s_2)(9 + 2\sigma^2(1+\rho) + 6s_2 - 6s_1) \\ p_2 &= \tfrac{t}{18}(3 + 2M - s_1 - s_2)(9 + 2\sigma^2(1+\rho) + 6s_2 - 6s_1) \end{aligned} \tag{8}$$

$$\begin{aligned} \pi_1 &= \tfrac{t}{108}(3 - 2M + s_1 + s_2)^2(9 + 2\sigma^2(1+\rho) + 6s_2 - 6s_1) \\ \pi_2 &= \tfrac{t}{108}(3 + 2M - s_1 - s_2)^2(9 + 2\sigma^2(1+\rho) + 6s_2 - 6s_1) \end{aligned} \tag{9}$$

Ex ante, we do not know what signals that the firms will receive. Next, considering all possible signals that firms might receive, we summarize the firms' expected equilibrium locations, prices, and profits, as well as consumer surplus and social welfare.

(a) Locations:

$$\mathbb{E}(x_1) = M - \tfrac{3}{4} - (1+\rho)\tfrac{\sigma^2}{6} \tag{10}$$

$$\mathbb{E}(x_2) = M + \tfrac{3}{4} + (1+\rho)\tfrac{\sigma^2}{6} \tag{11}$$

(b) Prices:

$$\mathbb{E}(p_1) = \mathbb{E}(p_2) = \tfrac{3t}{2} + \tfrac{t}{3}(1+\rho)\sigma^2 \tag{12}$$

(c) Profits:

$$\mathbb{E}(\pi_1) = \mathbb{E}(\pi_2) = \tfrac{t}{108}\left[9 + 2\sigma^2(1+\rho)\right]^2 \tag{13}$$

(d) Consumer Surplus (CS):

$$\mathbb{E}(CS) = V - \tfrac{85t}{48} - \tfrac{\sigma^2 t}{2} - \tfrac{\sigma^2 t}{108}(153 + \sigma^2) - \tfrac{\sigma^2 t}{108}\left[45 + \sigma^2(2+\rho)\right]\rho \tag{14}$$

(e) Social Welfare (SW):

$$\mathbb{E}(SW) = V - \tfrac{13t}{48} + \tfrac{\sigma^2 t}{108}(7\sigma^2 - 81) + \tfrac{\sigma^2 t}{108}\left[27 + 7(2+\rho)\sigma^2\right]\rho \tag{15}$$

where $\rho \in [0, 1]$. Notice that $\rho = 0$ is the case in which the firms have independent signals; $\sigma = 0$ is the case without uncertainty.

We next examine the effect of uncertainty regarding the demand on firms' product design decisions and firms' profits. For the comparison purpose, we next use the regular notations (e.g., π_i) for the scenario without uncertainty and use the notations with hats (e.g., $\hat{\pi}_i$) for the scenario uncertainty.

Proposition 1. *Compared to the case without uncertainty, in the presence of uncertainty ($\sigma^2 > 0$):*

(a) Product differentiation is higher; that is, $\mathbb{E}(x_2 - x_1) < \mathbb{E}(\hat{x}_2 - \hat{x}_1)$*;*

(b) Prices are higher; that is, $\mathbb{E}(p_i) < \mathbb{E}(\hat{p}_i)$*;*

(c) Firm profits are higher; that is, $\mathbb{E}(\pi_i) < \mathbb{E}(\hat{\pi}_i)$*;*

(d) Consumer surplus is lower; that is, $\mathbb{E}(CS) > \mathbb{E}(\hat{CS})$*;*

(e) Social welfare is lower; that is, $\mathbb{E}(SW) > \mathbb{E}(\hat{SW})$*.*

As in the standard "location-then-price" games (page 279-281, Tirole, 1988), in choosing their locations, the firms tradeoff two effects: the *demand effect* and the *strategic effect*. In the case without uncertainty (such that the firms know exactly the consumer space), on the one hand, each firm wants to move toward the center M to increase his demand, which is called the *demand effect*. On the other hand, moving toward the center could increase the competition with his rival and decrease the prices, which is called the *strategic effect*. In balancing the two effects, in equilibrium one firm choose to locate at $M - \frac{3}{4}$ and the other at $M + \frac{3}{4}$. In the presence of uncertainty, the two effects continue to exist in the firms' location decision making process. However, the impact of the uncertainty on the two effects is asymmetric. The strategic effect works similarly as in the case without uncertainty, because, in stage 2, the uncertainty is resolved and differentiating from each other softens the price competition in each realization. The demand effect, in contrast, is weakened by the uncertainty, because, in the presence of the uncertainty, the firms are not sure about the location of M and the realizations in which M turns out to be close to a firm's location itself could give the firm a great demand. Because of the weakened demand effect in the tradeoff, in the presence of uncertainty, the firms choose to differentiate further from each

other, compared to the case without uncertainty.

Because of the increased differentiation, the competition is softened and the firms charge higher prices and earn higher profits in equilibrium. On average consumers are hurt because of the increased prices and increased misfit costs resulting from the increased differentiation. Social welfare is also hurt by the uncertainty. Notice even in the case without uncertainty, the competition between the two firms leads to excess differentiation. To minimize the total misfit costs, a social planner would choose to locate the two firms equidistantly on either side of the middle of the segment; that is, one at $M - \frac{1}{4}$ and the other at $M + \frac{1}{4}$. But, the competition equilibrium leads to the structure with one firm at $M - \frac{3}{4}$ and the other at $M + \frac{3}{4}$. So the equilibrium differentiation in the case without uncertainty is excess. In the presence of uncertainty, the firms are even further differentiated, which hurts the social welfare because of larger misfit costs.

In the absence of user-generated content, we assume that firms conduct their own research and each firm uses his own private information independent with the competitor's; that is, $\rho = 0$. As user-generated content become commonly available to firms, it provides the same additional information to both firms. As a result, firms' estimate about consumer taste is more accurate, and meanwhile their estimates are more correlated; that is, $\sigma_w^2 < \sigma_{wo}^2$ and $\rho \geq 0$. Next we examine the effect of user-generated content on firms' product design decisions and profits. We use the notation with subscript "wo" and "w" for the case without and with user-generated content (e.g., $\hat{\pi}_{i,wo}$ and $\hat{\pi}_{i,w}$).

Proposition 2. *Compared to the case without user-generated content (with $\sigma^2 = \sigma_{wo}^2$ and $\rho = 0$), in the presence of user-generated content (with $\sigma^2 = \sigma_w^2 < \sigma_{wo}^2$ and $\rho > 0$):*

(a) Product differentiation is higher (i.e., $\mathbb{E}(\hat{x}_{2,wo} - \hat{x}_{1,wo}) < \mathbb{E}(\hat{x}_{2,w} - \hat{x}_{1,w})$) if and only if

$$\rho > \frac{\sigma_{wo}^2 - \sigma_w^2}{\sigma_w^2} \tag{16}$$

(b) Prices are higher (i.e., $\mathbb{E}(\hat{p}_{i,wo}) < \mathbb{E}(\hat{p}_{i,w})$*) if and only if*

$$\rho > \frac{\sigma_{wo}^2 - \sigma_w^2}{\sigma_w^2} \tag{17}$$

(c) Firm profits are higher (i.e., $\mathbb{E}(\hat{\pi}_{i,wo}) < \mathbb{E}(\hat{\pi}_{i,w})$*) if and only if*

$$\rho > \frac{\sigma_{wo}^2 - \sigma_w^2}{\sigma_w^2} \tag{18}$$

(d) Consumer surplus is lower(i.e., $\mathbb{E}(\hat{CS}_{wo}) > \mathbb{E}(\hat{CS}_w)$*) if and only if*

$$\rho > \frac{\sqrt{2025\sigma_w^4 - 432\sigma_w^6 + 612\sigma_w^4\sigma_{wo}^2 + 4\sigma_w^4\sigma_{wo}^4}}{2\sigma_w^4} - \frac{45 + 2\sigma_w^2}{2\sigma_w^2} \tag{19}$$

(e) Social welfare is higher (i.e., $\mathbb{E}(\hat{SW}_{wo}) < \mathbb{E}(\hat{SW}_w)$*).*

The effects of user-generated content on firms' are two-fold. First, user-generated content provides additional information for each firm, and thus firms are better informed and their estimates of consumer taste are more accurate. We call this *variance-reducing* effect. Second, user-generated content is public and common, and thus it adds a common information resource to each firm's private information set. As a result, the firms' signals are more correlated because of user-generated content. We call this *correlation-increasing* effect.

The variance-reducing effect embedded in user-generated content tends to induce firms to less differentiate from each other and intensify the competition. As we explained for Proposition 1, with the uncertainty, because firms are not sure where the demand is, they has less incentive to move toward his rival to compete for the demand; in other words, the *demand effect* aforementioned is lessened. Because user-generated content reduces the uncertainty in the demand, it induces firms to compete more aggressively and position their products closer to each other, which hurts the firms.

The correlation-increasing effect, in contrast, can benefit the firms. When the firms' signals are positively correlated, each firm can infer the rival firm's signal, based on his own observed signal. The extreme case is that with perfect correlation each firm learns his

competitor's signal exactly. When firms know each other's signal better, the *strategic effect* aforementioned works better and plays a more salient role in the tradeoff of positioning his product. Being blind to each other's signal (in the case with independent signals, as in the case without user-generated content), firms' intended differentiation could result in similar product designs in some realization, for example, in cases in which firm 1 receives a high s_1 and firm 2 receives a low s_2 (noticing firms' product design strategies: $x_1 = s_1 - \frac{3}{4} - (1+\rho)\frac{\sigma^2}{6}$ and $x_2 = s_2 + \frac{3}{4} + (1+\rho)\frac{\sigma^2}{6}$). Therefore, the more correlated information can help the firms better "coordinate" their product positioning.

Whether firms lose or benefit because of user-generated content depends on the interaction between the two effects. When the correlation-increasing effect dominates, the firms benefit from the user-generated content. In this case, the expected product differentiation is larger and the expected prices are higher. The effect of user-generated content on consumer surplus is similar.

The real benefit brought by user-generated content is realized in social welfare. Recall that the competition in general leads to excess differentiation. In the presence of user-generated content, the variance-reducing effect induces firms to compete aggressively and thus reduces the differentiation, which benefits social welfare. The correlation-increasing effect can reduces the variance of the difference between the two product designs, which also benefits social. As a result, both effects can help increase social welfare and the social welfare is always higher in the presence of user-generated content.

We next delineate how the firm's profits and consumer surplus in the presence of user-generated content change with the correlation, compared with the case without user-generated content, as in Figure 1. In the first range (I) with sufficiently low correlation, firms lose while consumers benefit in the presence of user-generated content because the variance reduction in firm's signal plays a dominating role. In contrast, the third range of ρ (III) shows the opposite because the increased correlation plays a dominating role. In the second range (II), in which the firm signals are moderately correlated, both firms and consumers can be better off. We summarize this result as follows.

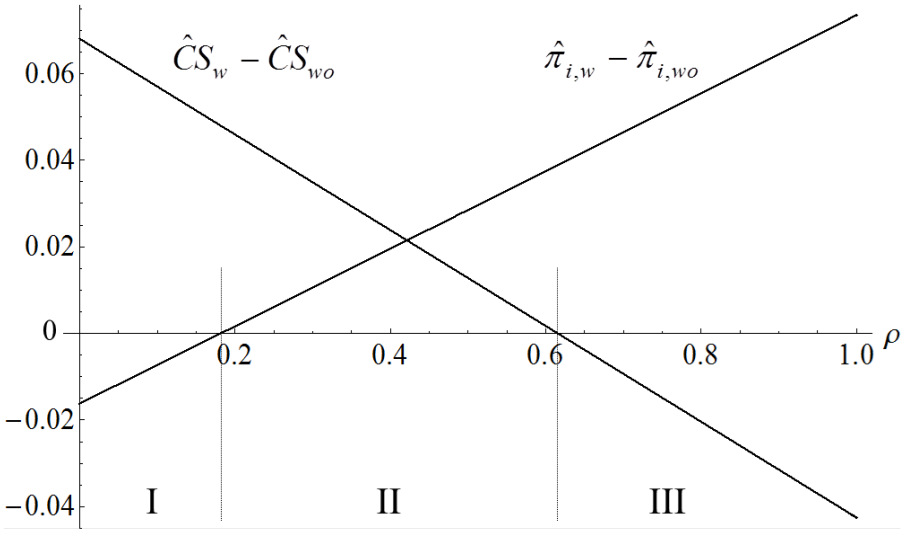

Figure 1: Firm Profit and Consumer Surplus
($\sigma_w = 0.23$, $\sigma_{wo} = 0.25$, $t = 5$, and $V = 20$)

Corollary 1. *In the presence of user-generated content, both firms and consumers are better off when*

$$\rho \in \left[\frac{\sigma_{wo}^2 - \sigma_w^2}{\sigma_w^2},\ \frac{\sqrt{2025\sigma_w^4 - 432\sigma_w^6 + 612\sigma_w^4\sigma_{wo}^2 + 4\sigma_w^4\sigma_{wo}^4}}{2\sigma_w^4} - \frac{45 + 2\sigma_w^2}{2\sigma_w^2} \right] \tag{20}$$

Corollary 1 suggests that user-generated content in our setting may lead to a win-win result in equilibrium; that is, both firms and consumers can be better off in the presence of user-generated content if the correlation between firms' signals is moderate. This win-win result is possible because the social welfare generated is higher or the total "pie" is bigger in the presence of user-generated content.

4 Conclusion

We examine the effect of online user-generated content on the competing firms' product design decisions when they sell substitutable products and face uncertain consumer taste. Because user-generated content provides additional information about consumers and is common to the firms, it reduces firms' uncertainties about consumers and increases the correlation of firms' information. We demonstrate that uncertainty reduction can hurt firms because reduced uncertainty intensifies the competition, while the increased correlation can benefit

them because one firm can better infer the other's signal and thus better "coordinate" their product positioning.

Our results have several implications. First, our results suggest that user-generated content increases the social welfare or the joint benefit for the firms and consumers. The third-party platforms such as Facebook and Blogger.com, supported by their own revenue source, effectively facilitate and foster users to generate content and ultimately benefit the society. Therefore, these platforms or initiatives emerging with Web 2.0 technologies should be encouraged and supported.

Second, firms do not necessarily benefit from user-generated content—firms could benefit only from the increased correlation between firms' signals, but hurt by the reduced uncertainty. Managers may want to listen to the consumers' opinions to learn more about the demand, but, to really benefit from the consumers' opinions, firms should have the content created by consumers more open to each other. Currently, many online communities, such as IdeaStorm and myStarbucksIdea, are open to the public, including to their competitors, which indicates these firms' practice is consistent with our prescription. Furthermore, firms with their own platforms for user-generated content should even invite or encourage their rivals to their platforms. By doing so, firms can better predict each other's understanding of consumer taste and thus better coordinate their product offerings.

We also find that when the variance-reducing effect and correlation-increasing effect are comparable, a "win-win" result might arise in which both firms and consumers benefit from user-generated content. In this case, the consumers' incentive is aligned with the firms', and the platform or communities initiated by the firms are more sustainable.

Our results also point toward further research. For example, we find that when the variance-reducing effect dominates the correlation-increasing effect, the firms can be hurt by user-generated content. Then, one natural question is why firms have incentive to incorporate the user-generated content in the first place. Our preliminary analysis shows that the surprising outcome could be a result similar to a rat race or prisoner dilemma—each firm has incentive to incorporate user-generated content, given the rival's not doing so. However,

when both firm incorporate the additional information, neither benefits from it.

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