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Selling to customers with both Veblen and network effects

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ABSTRACT

For the products that provide not only intrinsic value from their functions but also stylish consumption experience, there often exist both Veblen and network effects. Some customers are more likely to purchase the product if fewer customers can afford it, while others might appreciate the existence of more peers. Focusing on these products, we study the market equilibrium under rational expectations. The optimal pricing and quantity decisions reveal interesting insights about the effects of such mixed consumption externalities.

1. Introduction

The modern technology has led more and more products, such as the mobile/wearable devices, the smart appliances, and the electric/autonomous vehicles, to provide not only intrinsic value from their functions but also stylish consumption experience [1,3,4]. Such fashion tech products often exhibit mixed consumption externalities. On the one hand, to prove their wealth and social status, some snobbish customers would be more willing to purchase a product if fewer can afford it—the typical Veblen effect [13]. On the other hand, the purchase of a product with significant technology accumulation and usage interaction can also be influenced by the network effect. For instance, as the number of users increases, these tech products might generate more value with enhanced supporting facilities and services provided by either the firm or third-party developers. As a result, some customers, whom we call the followers, may instead prefer high availability of the products which can yield them more utility from the consumption.

The presence of the above two effects makes it important to properly market and produce the product. As revealed in the literature, the Veblen effect often calls for high prices with small quantities, which can create uniqueness and scarcity to induce conspicuous consumption [2,8,12]. However, an unbalanced strategy can lead to an inadequate user base which might result in a failure of a tech product with insufficient value. One interesting example is the Google Glass Explorer Edition that was released in 2012 but discontinued in 2015, despite the quick adoptions by the snobbish customers. One major criticism, beyond the safety and privacy concerns, was the limited amount of applications due to its small user base relative to the high price [4]. On the contrary, the network effect implies improved product value if there is more consumption [7]. As such, some research has studied boosting customer utility by strategies such as penetration pricing [6,11,14]. Strategic consumer behavior is another important factor for fashion products. As studied in prior literature [5,10,12], customers might wait for markdowns amid market uncertainty, which affects a firm's profitability. However, none of the extant research has investigated the setting with both Veblen and network effects under demand uncertainty.

Motivated by the above observations, we develop a model in this paper based on the newsvendor framework where the potential customers exhibit different consumption externalities. There is a group of snobbish customers, another group of followers, and the remaining customers are the commoners who are not subject to either the Veblen or the network effect. The firm sets the price and the production quantity of the product. We find that the optimal strategy is affected by the dominating customers as well as the magnitude of the two consumption externality effects. In particular, when the fraction of snobbish customers is large, the firm sets a high price to market the product only to the snobbish customers, and such a strategy is more likely to be followed if the Veblen effect among these customers becomes

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stronger. Moreover, we find that when the fraction of followers remains small, a slight increase of these customers relative to the commoners or an increase of their sensitivity to the network effect might make the firm more inclined to only target the snobbish customers. After the fraction of followers exceeds a critical level, the firm might start to target the followers; however, such a decision becomes independent of the exact amount of followers but depends on the proportion of snobbish customers relative to the commoners. Finally, we find that the firm's production quantity does not necessarily increase as it targets more types of customers. In fact, in some circumstances, the optimal quantity can be the smallest when the firm sells to all types of customers compared to only selling to a part of the customers.

The remainder of the paper is organized as follows. Section 2 presents the model, and we analyze the optimal marketing and production strategies in Section 3.

2. Model

Following prior literature [5,10,12], we adopt the newsvendor framework for our study. We assume that the fashion tech product is produced by a monopolist firm at a unit cost c. The firm aims to sell the product in one season. The total number of potential customers, D, is ex ante random that follows a cumulative distribution F_D with a density function f_D. We assume that F_D has an increasing generalized failure rate. The firm needs to decide the selling price, p, and the production quantity, Q, before the selling season starts. After the selling season, if there is leftover inventory, the firm salvages the inventory at some fixed price $s < c$.

The potential customers are heterogeneous. There is a fraction, β_c, of regular customers who value the product at a constant, v, which is independent of the time of purchase, the product's market positioning and the sales volume. We call these customers the commoners and v represents the intrinsic value of the product. Besides commoners, another fraction, β_s, of the customers exhibit snobbish behavior, referred to as snobs. Their valuation of the product will be higher than v if the product is made affordable only for them, and it increases as the availability of the product decreases. Similar to [12], we assume that the snobs value the product in the regular season at $v + k_s \cdot \varepsilon_s$, if the product is priced as being affordable only for them, where ε_s is the corresponding stockout probability they expect and $k_s > 0$ represents their sensitivity towards product availability. If the product is priced as being affordable also for other types of customers, snobs would value the product at its intrinsic value v. Similarly, if they purchase the product after the regular selling season, the snobbish perception diminishes and their valuation of the product would be again at its intrinsic value v. In contrast to these two groups of customers, we assume that there is another type of customers with a fraction $\beta_f = 1 - \beta_c - \beta_s$, referred to as the followers, who view the product's intrinsic value v to be achievable only if the product is made available to all potential customers. Specifically, we assume that they value the product in the regular season at $v + k_f \cdot \varepsilon_s$, if it is priced as being affordable for all types of customers, where ε_s is their expected stockout probability of the product and $k_f < 0$ represents their sensitivity towards product availability (we assume $k_f > s - v$ in our analysis to eliminate trivial outcomes). After the regular selling season, if there is leftover inventory, which means the product is available to all potential customers, their valuation of the product will reach v as the firm salvages the inventory. The above customers are all strategic who will decide when to purchase the product based on utility expectations (for simplicity, we do not consider time discount).

3. Analysis

We first present the newsvendor framework. Let x^+ denote $\max(x, 0)$. Suppose the firm prices the product at p in the regular selling season, under which the market demand follows a random variable $d(p)$. The firm needs to decide the production quantity before the realization of the demand. Thus, given the salvage price s and the production cost c, the expected profit function of the firm can be written as:

$$\begin{aligned}\Pi\,(p,q) &= E\left[p\cdot \min\left(d(p),q\right) + s\cdot (q-d(p))^{+} - c\cdot q\right]\\ &= (p-s)\cdot E\left[\min\left(d(p),q\right)\right] - (c-s)\cdot q.\end{aligned}$$

The firm's goal is to find the optimal price and production quantity that maximize its expected profit; i.e.,

$$(p^*, Q^*) = argmax_{p,q}\Pi\,(p,q)\,.$$

Based on the specification of the customers, the firm has three product positioning strategies in the regular selling season, targeting: the snobs only (Strategy A), the snobs and the commoners (Strategy B), and all types of customers (Strategy C). The customers are strategic and they will time their purchases. Corresponding to the firm's product positioning strategy, we can formulate the utility function of the threshold type of customers of purchasing the product in the regular selling season or waiting for the salvage:

Strategy A: $U_{snob} = \max\{v + k_s\cdot\varepsilon_s - p,\ (1-\varepsilon_s)\cdot(v-s)\}$.
Strategy B: $U_{commoner} = \max\{v - p,\ (1-\varepsilon_s)\cdot(v-s)\}$.
Strategy C: $U_{follower} = \max\left\{v + k_f\cdot\varepsilon_s - p,\ (1-\varepsilon_s)\cdot(v-s)\right\}$.

The utility in the regular selling season is the difference between the customers' valuations and the price p. The expected utility in the salvage period is the difference between the intrinsic value v and the salvage price s, multiplied by the probability of non-stockout, $1 - \varepsilon_s$. Since the inventory level is not observed by the customers, each strategic customer has to form a belief over the stockout probability during the regular selling season. Here, we assume that the customers have the same estimation of the stockout probability. Similar assumptions have been made in prior literature [5,10,12]. The customers will choose to buy in the regular selling season if their utility is no less than that of buying from the salvage. Hence, corresponding to the firm's product positioning strategies, the reservation prices of the customers in the regular selling season can be concluded as: $r_s > r_c > r_f$, where $r_s = \varepsilon_s\cdot(k_s + v - s) + s$, $r_c = \varepsilon_s\cdot(v-s) + s$, and $r_f = \varepsilon_s\cdot\left(k_f + v - s\right) + s$.

To analyze this problem, we adopt the Rational Expectation (RE) equilibrium concept [9]. Similar to prior literature [5,10,12], any equilibrium in our study consists of a pair of functions describing the firm's strategy and the customers' expectations, under a common information set of the model specifications, where the firm's strategy maximizes its profit based on its belief of the customers' expectations, while the customers' expectations based on their own beliefs are consistent with the firm's strategy. We write the equilibrium conditions in Table 1.

The conditions iv and v indicate that in the RE equilibrium, the expected stockout probability formed by the customers equals the actual stockout probability and the expected reservation price predicted by the firm equals the actual reservation price of customers.

Proposition 1. *Under each product positioning strategy, the firm's optimal pricing and quantity decisions in equilibrium can be characterized by Table 2.*

Proof. If the firm sets the price at the reservation price of the snobs, the commoners and followers cannot afford it and the total demand is $\beta_s D$. Plugging the equilibrium condition iv into condition iii, we have

$$\begin{aligned}p &= \bar{F}_{\beta_s D}\left(Q_A^*\right)\cdot(k_s + v - s) + s\\ &= P\left(\beta_s\cdot D > Q_A^*\right)\cdot(k_s + v - s) + s.\end{aligned}$$