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Impact of Consumers' Risk Attitude on a Firm's Intertemporal Pricing Strategy

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Abstract

We consider a firm selling a new product to a market wherein customers are uncertain about their valuation of the product. This uncertainty can be resolved through a costly search for product information. The incentive which motivates the customers to engage in information search depends on their attitudes towards risk. There are two periods over which the firm can dynamically adjust the price to sell the product. Based on the price offered in each period, the customers choose either to search, to buy, or not to buy. We examine the optimal intertemporal pricing strategy under such settings and provide insights into how the firm should induce the customers of each type to search over time.

Keywords

Consumers' Risk Attitude, Pricing Strategy

1. Introduction

Valuation uncertainty arises if the product is a new or innovative item, a media item, or if consumers are uncertain about their idiosyncratic usefulness for the item. We propose a model of dynamic pricing for a monopolist who sells a completely new durable product over time. Initially, neither the seller nor the consumers are certain about the usefulness and value of the product. An example is the launch of iPad in April 2010 when it was so new that some wondered if it would be just an "oversized iPhone that cannot make a call" or the "third-category device that can do everything—from web-browsing, email, photos, videos, music to e-books—better than either a smartphone or a laptop."

Product valuation uncertainty is resolved through any one of three ways: consumers can engage in a costly evaluation task (much in the same manner as the correspondent in the Economist quote), purchase the product, or learn about the

product value at a later period from those consumers who have discovered it through evaluation or purchase (e.g., through reading articles like the Economist piece on iPad). We also allow consumers to buy the product without first discovering their valuation. The pricing strategies adopted by the monopolist seller may encourage or discourage consumers to engage in costly product evaluation in the first period. The outcome of product evaluation and first period sales provide a basis for consumer social learning in the second period, which in turn determines the seller's profitability. In this research, we derive equilibrium pricing strategies for the monopolist seller for the two periods which may encourage or discourage consumer evaluation.

Consumers decide to engage in such costly evaluation task only if its expected benefit outweighs the evaluation cost. This decision is partly affected by their risk preferences which reflect their attitude toward perceived risk in consumption. Bauer (1960) has suggested that consumer behavior can be seen as an instant of risk taking. While seeking information before purchase is appealing in the sense that it helps reduce risks involved in consumption, consumers' decision on whether to evaluate search extensively relies on their tolerance of risk. Intuitively, risk-averse consumers are more likely to find out about the product value since they are more sensitive to consumption risks. Thus, all else being equal, they are more likely to refrain from making a purchase in the first period.

This model assumes that consumers and the firm can learn about the product value over time. In particular, we assume that the first period is long enough so that by the second period there is fairly accurate information about the product value. Those consumers who remain on the market in the second period can learn by reading extensively (e.g., online reviews, news stories, and industry research reports), talking to friends, and witnessing early adopters around them. As such, information externality arises as a consequence of consumer actions in the first period. The two-period model proposed here captures the learning process and allows the firm the opportunity to sell its product again after sufficient product value information is obtained.

This study aims to answer the following questions. When the market contains consumers who can learn about product value through costly evaluation, how should the firm price its product optimally? Should the first-period price be set in such a way that consumers are encouraged (or discouraged) to discover the true product value through costly evaluation? How would the firm's profits be affected by consumer risk attitudes and the level of uncertainty? We characterize the optimal dynamic pricing strategies for the monopolist.

2. Literature Review

The study lies in the intersection of the following streams of research on product information structure, consumers' risk attitude and learning, and strategic pricing under uncertainty.

2.1. Product Valuation Uncertainty

This research builds on prior research on product valuation uncertainty. Shugan (1980) considers the costs of thinking and provides a quantitative measure of that cost related to the number of comparisons necessary to make a decision, given some level of confidence. The consumer behavior literature on information processing and product categorization already posits the general idea that cognitive effort can be context dependent. Whether to engage in product evaluation before making the purchase decision is affected by a number of factors. Prior literature has identified the influence of evaluation costs and found that consumers would not engage in information acquisition unless the marginal benefits from the information outweigh the costs involved. Wathieu and Berniti (2007) study a single-period model and show that a monopolist can charge a high price which induces consumers to think about the uncertain product benefit and gain clarity over its personal relevance. Guo and Zhang (2012) study the use of firm strategies to induce or prevent consumer deliberation about the personal relevance of the product. The proposed research departs from the consumer evaluation literature by considering a second period in which the product value information generated in the first period can be transmitted to the second period. Adding a second period provides an opportunity for the firm to sell the product again and with full product information (Lazear, 1986).

2.2. Risk Attitude

Prior literature has discussed consumer risk attitude in a number of contexts, such as product warranties (Padmanabhan & Rao, 1993; Lutz & Padmanabhan, 1995), return policies (Che, 1996), consumer preference over online shopping (Gupta et al., 2004), marketing communication allocation (Narayanan & Manchanda, 2009), and the profitability of advance selling (Xie & Shugan, 2001). None of them has considered this issue in consumer decision to evaluate an innovative product. Kalish (1985) is more closely related to the proposed model where consumer risk aversion on the new product adoption and provides a policy for the seller's advertising and price strategy over time. Our work differs in that we explicitly model how consumers become informed of the product valuation at the initial and later periods.

2.3. Consumer Learning

This work is also related to the information cascades and observational learning literature where individuals make decisions sequentially. This literature has traditionally distinguished consumer information sources into private and public ones. We adopt the same distinction and consider the scenario where some consumers become better informed through obtaining private information earlier in the product diffusion process, whereas some others wait till a later period to observe the adoption outcome. Banerjee (1992) and Bikhchandani, Hirshleifer and Welch (1992) provide explanation about how fads can rise and disappear in

the population when agents put too much weight on the past actions of predecessors. However, to the best of our knowledge, none of these papers has explained how consumers obtain the private signal in the first place except that consumers are somehow endowed with it and the question faced by consumers is to what extent they should rely on their private signal or the predecessors' actions. One exception is Burguet and Vives (2000) where they formally model the cost to acquire information and draw implications of this cost for the accumulation of public information. However, their model abstracts away the endogeneity in pricing decisions that a firm could use to affect the information acquisition.

Moreover, this study contributes to the literature on monopolist strategies to influence consumer information acquisition. Numerous studies show that the firm can induce consumer to obtain product information through marketing tactics such as the informativeness of advertising (Mayzlin & Shin, 2011), the design of its product line (Guo & Zhang, 2012; Xiong & Chen, 2013), and its charged price (Wathieu & Bertini, 2007; Branco et al., 2012). Our work echoes Wathieu and Bertini (2007) and Branco et al. (2012) in that the firm can strategically choose its price to affect the consumer evaluation decision.

Focusing on sequencing decision of a monopolist, Sgroi (2002) and Liu and Schiraldi (2012) both study how a seller can influence the herd by choosing the number of consumers to serve in the first period. In particular, Sgroi (2002) allows the firm to directly force a subset of consumers to make their adoption decisions in the first period (determining the number of "guinea pigs") whereas this paper uses price to encourage or discourage consumer product evaluation in a subtler way. In this model, price serves two functions: it extracts rent from the current period buyers; and it encourages or prevents consumers to engage in costly evaluation to discover their own product valuation. The second function in turn affects the product demand and eventually the sales information transmitted to the nonadopters in the second period. In a two period model about consumer learning over a horizontal attribute, Jing (2011) also considers a monopolist's strategic use of informative advertising about the product's match value in the first period to manipulate consumer information, where the consumers' evaluation decision is not considered.

3. The Model

We consider a two-period model where a monopoly seller launches a new product at the beginning of the first period and sells it in both periods. The market consists of a continuum of consumers with unit mass. Each consumer demands no more than one unit of the product over the entire horizon. The marginal cost of production is normalized to zero.

3.1. Uncertainty

There is a two-sided information asymmetry between the firm and consumers in the market. That is, the firm knows the characteristics of the product and con-

sumers know their own tastes, but it is unknown to both sides how much consumers would enjoy this product or how much consumers are willing to pay for it. In other words, the match value between the underlying features of the product and consumers' usage preference is publicly unknown. Extensive economic literature has studied this bilateral uncertainty, which is especially common in the introduction stage of an innovation (e.g., Liu & Schiraldi, 2012). To capture this uncertainty, we assume that consumers are heterogeneous with respect to the product value *v*. Thus, there are two types of potential buyers: a fraction φ has a high valuation $v_H = 1 + R/2$ and the remaining fraction $1-\varphi$ has a low valuation $v_L = 1 - R/2$. Here the difference between the high and low valuations $R \in [0,1]$ denotes the range of product value uncertainty and is common knowledge. A priori, each consumer has no idea which type they belong to since his true valuation is *ex ante* uncertain. But everyone believes that his/her exact valuation will turn out to be high with a likelihood of $\varphi \in [0,1]$. The value of φ can be interpreted as an indicator of the market potential of the product, determined by factors such as the seller's reputation and consumer characteristics (demographic and/or socioeconomic). These factors are determined exogenously but can be observed by the firm and consumers.

3.2. Consumption Utility

We adopt the *von Neumann-Morgenstern* utility function $u(x)$, where $x = v - p$ is the consumer surplus from purchasing with realized value v at price p. Assume that consumers are risk averse and thus prefer a certain amount of surplus x (*deterministic consumption*) to any risky prospect with expected value equal to x (*risky consumption*), i.e., $u'(x) > 0$ and $u''(x) \le 0$. The utility from no purchase is normalized to zero, i.e. $u(0) = 0$. Given the seller's price decision p, the consumer's expected utility of risky consumption, denoted by $EU(p)$, can be specified as

$$\begin{aligned} EU(p) &= \varphi u(v_H - p) + (1-\varphi) u(v_L - p) \\ &= u\left(1 - \left(\frac{1}{2} - \varphi\right) R - \rho - p\right), \end{aligned} \tag{1}$$

where ρ is known as the risk premium. With the *Arrow-Pratt measure of absolute risk aversion* (see Pratt 1964) defined as

$$A = -\frac{u''}{u'} \ge 0, \tag{2}$$

the risk premium is approximately given by

$$\rho \cong A\frac{\varphi(1-\varphi)R^2}{2} \ge 0. \tag{3}$$

3.3. Product Evaluation

Before making the purchase decision, the consumers can choose to incur a fixed evaluation cost κ to uncover the true product valuation. This evaluation cost can include monetary cost, travelling cost, time, cognitive or other efforts. Con-

sistent with prior literature (e.g., Guo & Zhang, 2012; Xiong & Chen, 2013), we assume that the product valuation can be fully discovered through evaluation. After evaluation, the consumer surplus is $-\kappa$ (because a rational seller will never set the price below v_L) if the product valuation turns out to be low, whereas it is $v_H - p - \kappa$ on the other hand. To avoid the uninteresting case, we assume that the evaluation cost κ is not too large to render evaluation never appealing to consumers. Accordingly, the consumer's expected utility from evaluation, denoted by $EU_e(p)$, can be stated as

$$\begin{aligned} EU_e(p) &= \varphi u(v_H - p - \kappa) + (1-\varphi)u(-\kappa) \\ &= u\left(\varphi\left(1+\frac{R}{2}-p\right) - \rho_e - \kappa\right), \end{aligned} \tag{4}$$

where the risk premium is characterized by

$$\rho_e \cong A\frac{\varphi(1-\varphi)(1+R/2-p)^2}{2} \geq 0. \tag{5}$$

3.4. Process of Consumer's Buying Decision

The process of consumer's buying decision is illustrated in Figure 1. In particular, all consumers arrive at the beginning of the first period and exit after adoption. In period 1, where no information about the production valuation is available, the consumers decide whether to engage in evaluation. Given the price p_1, they choose to evaluate if the resulting expected utility specified in (4) is weakly higher than that given in (1) yielded by making a risky consumption; that is

$$EU_e(p_1) \geq EU(p_1). \ (\textit{Incentive Compatibility}) \tag{6}$$

After learning the product valuation from evaluation, the consumers will adopt only if the resulting surplus is nonnegative (i.e., $v \geq p_1$). If the consumers decide not to evaluate, they will make a risky consumption if the expected utility from doing so is non-negative (i.e., $EU(p_1) \geq 0$). The consumers' best reaction to p_1 in the first period is illustrated in Figure 2. In period 2, the seller sets the price p_2 and the remaining consumers decide whether to adopt based on a similar rationality.

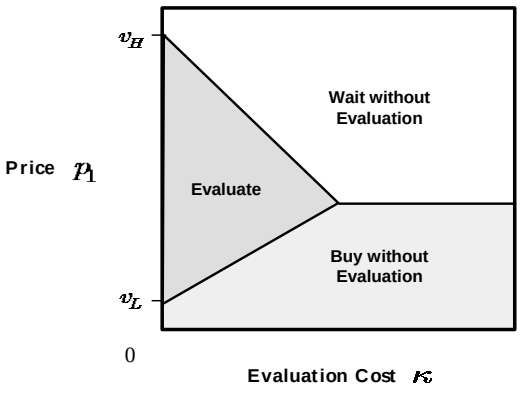

Figure 1. Consumer's best reaction in period 1.

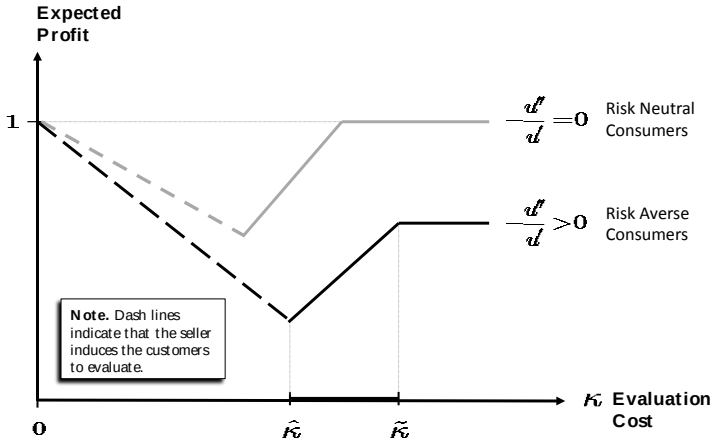

Figure 2. The seller's expected profit.

4. Analysis and Result

The seller has two possible pricing strategies: *inducing evaluation* and *preventing evaluation*.

4.1. Inducing Evaluation

The seller can price p_1 in such a way that consumers are enticed to make a costly evaluation before deciding to purchase. With such a strategy, the optimal first period price should result in a higher expected utility from evaluation compared with no evaluation; that is, the *incentive compatibility constraint* specified in (6) must be satisfied. In addition, the expected utility from evaluation must be non-negative, i.e., $EU_e(p_1) \geq 0$ (*individual rationality constraint*). As the consumers' risk attitudes are homogeneous, they make the same decision regarding whether to evaluate. If consumers evaluate, those who learn that their valuation $v \geq p_1$ will adopt in Period 1. Since there are two periods, the seller will rationally set the clearance price $p_2^* = v_L$ to sell to the low valuation customers in Period 2. The seller maximizes the expected profit subject to the constraints stated above.

4.2. Preventing Evaluation

If the seller decides to prevent evaluation, it is optimal to encourage all consumers to make a risky consumption in the first period because they react identically with homogeneous risk attitude. Accordingly, the price charged in the first period must ensure that the consumers' expected utility from buying without evaluation is non-negative (i.e., $EU(p_1) \geq 0$) and higher than that from evaluation (i.e., $EU_e(p_1) \leq EU(p_1)$).

4.3. The Results

Solving the problems demonstrated above, we obtain the optimal price in each period and the corresponding expected profits for each strategy. The results are summarized in Table 1.

Table 1. Optimal strategy with homogeneous risk attitudes.

Optimal		Optimal Prices	
Strategy	Condition	Period 1	Period 2
Induce Evaluation	$0 \le \kappa \le \hat{\kappa}$	$1+\frac{R}{2}-\frac{\varphi-\sqrt{\varphi^2-2A\varphi(1-\varphi)\kappa}}{A\varphi(1-\varphi)}$	v_L
Prevent Evaluation	$\hat{\kappa} \le \kappa \le \tilde{\kappa}$	$1+\frac{R}{2}-\frac{1}{A\varphi}+\frac{\sqrt{(1-\varphi)\left(A(1-\varphi)\kappa R+1\right)^2+2A\varphi\kappa}}{A\varphi(1-\varphi)}$	n/a
	$\kappa \ge \tilde{\kappa}$	$1+\frac{2\varphi-1}{2}R-\frac{A\varphi(1-\varphi)R^2}{2}$	n/a

Based on the results, the optimal expected profits with respect to different values of evaluation cost are illustrated in Figure 2. We find that the seller prefers to induce the consumers to evaluate only when the evaluation cost is not too high. And in this case, the seller's optimal expected profits are lower when the consumers have a higher evaluation cost.

Figure 2 also shows that the firm's optimal expected profits increase in the consumers' evaluation cost when the cost κ is above the threshold $\hat{\kappa}$. The intuition is that, when consumers have incentives to reduce their consumption risk by evaluating the product first—the seller, if it decides to prevent evaluation—must reduce its price to compensate the consumers for the risks they have to bear. When the evaluation cost is relatively low, this compensation becomes greater and the seller's optimal expected profits are lower.

5. Conclusion

While a new product is introduced into the market, consumers are typically ex-ante uncertain about how much they are willing to pay for it. To resolve this uncertainty before purchasing, they may engage in a costly evaluation to learn their product valuation. This study investigates the firm's strategic intertemporal pricing with regard to whether to induce or prevent the consumers to evaluate by taking into consideration their risk attitude. Specifically, we propose a two-period model where a monopolistic firm launches its product at the beginning of the first period and sells it over two periods. The firm determines whether to induce or prevent evaluation by setting a price for this period that maximizes its expected profits. All consumers arrive at the outset and after observing the price in the first period, they strategically make trade-offs between the expected utility from evaluation versus that from purchasing with no information. We find that consumers' risk attitude has a critical impact on the seller's pricing strategy and profitability.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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