INSTITUTO DE ECONOMÍA

DOCUMENTO de TRABAJO

486
2017

Convincing early adopters: Price signals and Information transmission

Nicolás Figueroa, Carla Guadalupi

www.economia.puc.cl • ISSN (edición impresa) 0716-7334 • ISSN (edición electrónica) 0717-7593

Convincing early adopters: Price signals and Information transmission

Nicolás Figueroa[†] Carla Guadalupi[†]

May 9, 2017

Abstract

We study the optimal pricing strategy for a new product when consumers learn from both prices and early adopters' purchase decisions. In our model, a long-lived monopolist faces a representative consumer each period. The monopolist is privately informed about his type, the probability of producing good-quality products. First-period consumers are early adopters, who learn quality before purchasing the product. Second-period consumers learn about product quality only after observing the public history, namely past price and early adopters' purchase decisions. In this context, prices play a dual role, acting as signals of the firm's type but also facilitating or impeding information transmission between early adopters and second-period consumers. Our main result is that separation might occur through either high or low prices (with respect to the full-information monopoly price), depending on the elasticity of demand. When demand for good-quality products is less elastic, high prices are less costly for high-type firms due to both a static (through demand) and dynamic (through information transmission) effects. On the one hand, high-type firms are marginally less affected by high prices, since they lose fewer consumers. On the other hand, early sales at higher prices carry good news about quality to second-period consumers, since such sales are more likely to come from a good than from a bad-quality product. The opposite happens occurs when demand for good-quality products is more elastic. We provide two market examples for each case and show that in the case of disruptive (incremental) innovations high (low) prices can be used as signals of quality. We finally discuss consumer welfare under the two resulting alternative equilibria, and show that the observability of early adopters' purchase decisions improves consumer welfare when separation occurs through high prices.

[†]Instituto de Economía, Pontificia Universidad Católica de Chile, Vicuña Mackenna 4860, Santiago, Chile, E-mail: nicolasf@uc.cl.

[†]Departamento de Economía de Empresa, Universidad de las Islas Baleares, Ctra. Valldemossa km. 7.5, Palma de Mallorca, España, E-mail: carla.guadalupi@uib.es

1 Introduction

Markets for innovative products are characterized by uncertainty about a product's actual quality and suitability. Consider, for example, markets for high-tech consumer electronics (e.g., smart-phones, tablets, computers), and digital products (e.g., computer software, smart-phone apps). The firm is often better informed about the product's features, strictly related to the design and production process, but only after consumers have actually tried it out can the match between these features and consumers' needs and tastes be completely understood[1]. It is possible that a perfectly engineered product, thought to satisfy consumer's desires as expressed in marketing surveys, may leave consumers cold in the end[2]. Other products, like personal computers in the 1980s or the iPod in the early 2000s, can take the market by storm - fulfilling needs not even consumers knew they had. Natural consumer reluctance to try new products is a significant hurdle, since these are usually expensive, one-time purchases, which imply a long-term commitment to a technology or a brand. In these markets, early adopters play a crucial role in eliciting information, so much so that the final success of a product often depends on how well it performs with this, usually small, group of consumers. Early adopters often have the "final word" on the success of a new product, by understanding and communicating, through their purchase decisions, the actual match between the product and consumer needs.

In the early stages of a product's life cycle, then, the firm's pricing strategy should consider not only its confidence in the technical characteristics of the product (imperfectly correlated with consumers' satisfaction), but also the role of early adopters who influence future consumers' purchase decisions and quality assessment. In particular, when signaling quality through prices, firms must then take into account both a static (through demand) and dynamic (through information transmission) price effect. The static effect is well understood. If good-quality products face a less (more) elastic demand, a high-type firm can signal through high (low) prices, which would be prohibitively costly for a low-type firm. The dynamic effect (through information transmission) is more subtle. Sales at high prices carry better (worse) news to future consumers when good-quality products are less (more) elastic, making such prices an effective tool for a high-type monopolist to signal its type.

Our analysis sheds new light on skimming v/s penetration pricing strategies. Skimming, which involves

[1] The notion of quality here includes not only the product's features (e.g. performance, usability), but also the match between product characteristics and consumers' needs.

[2] Philips attempted to enter the videogame market in the late 1980s with the release of the "Compact Disk Interactive" (CD-i), a console which contained educational games and also played normal compact disks. Furthermore, the CD-i was complicated, and required a half-hour training session with an experienced sales person. An extremely high introductory price ultimately doomed the CD-i, as consumers opted for Nintendo gaming systems which sold for half the price of a new CD-i.

signaling through high prices, is used when good-quality products face a less elastic demand. This is not only because lower elasticity implies a smaller loss of consumers due to high prices (in the introductory period), but also because sales at high prices will carry good news to future consumers. Penetration pricing, on the other hand, is used when good quality is associated with higher elasticity. Here, low prices signal the firm's willingness to forego margin for quantity, and can be also interpreted as a gamble about massive adoption at low prices, which will generate good news for future consumers. As an example, consider Apple, which recently switched from a skim-pricing strategy (e.g. the original iPhone) to a penetration one (EarPods). We can rationalize this strategy as a move from a market where good quality implies a more inelastic demand, due to loyal consumers, to another one where good quality means broader consumer base, due to new adopters.

We consider a two-period model, in which a long-lived monopolist faces a potential buyer each period. The monopolist is privately informed about the probability of producing good-quality products[3]. First-period consumers are early adopters who learn product's quality even before purchasing it. Second-period consumers, on the other hand, learn about product quality only through the observation of public history, namely past price and early adopters purchase decisions. Early adopters' opinion about the product is the "final word" on its quality, but it is communicated imperfectly, since later consumers can only observe purchases, which are also influenced by individual tastes, fashions and fads that are irrelevant for the average consumer.

We analyze conditions for the existence of separating equilibria in which high or low prices can be used as signals of quality. We then provide an example for each case and discuss consumers' welfare under the two resulting alternative equilibria. Our main result is that separation might occur through high or low prices (with respect to the full-information monopoly price) depending on the elasticity of demand with respect to prices. When demand for good-quality products is less elastic, high prices are less costly for high-type firms due to both a static and dynamic effect. High-type firms, which are more likely to produce good-quality, are marginally less affected by high prices, since they lose less consumers. Moreover, early sales at higher prices would be more informative, since such sales would be more likely to come from a good than from a bad-quality product, the latter facing a significantly lower demand at this price. Therefore, by influencing the informativeness of early adopters' decisions, prices can be interpreted as an informed gamble about product's quality. The opposite happens when demand for good-quality products is more elastic.

To illustrate our point consider a firm introducing a potentially drastic new innovation that, if successful, would disrupt the market. In the case of a good-quality product, a fraction of consumers will face an inelastic demand. Thus a monopolist with sufficient confidence in the innovative power of its product will likely signal

[3]Products with a good match between consumers' tastes and product's features is good.

quality through high prices. Consider, on the other hand, the case of a firm introducing a new version of its flagship product. In the case of bad quality, only consumers already identified with the brand will be interested in updating - switching from the older version to the new one. However, good-quality products will appeal to a broader consumer base, including those who have purchased from a different firm in the past. In this case low prices will be interpreted as signal of confidence, both about the quantity a monopolist expects to sell and the buzz it expects to generate through early adopters.

We finally argue that separation is less costly for the high-type monopolist when early adopters' purchase decisions are observable. As a welfare implication, when second-period consumers cannot really count on early adopters' purchase decisions to infer product quality, consumers can be either better or worse off. In particular, when separation occurs through high prices, a higher cost of signaling implies higher prices, which are more detrimental for first-period consumers. On the other hand, when separation occurs through low prices, a higher cost of signaling translates into lower prices which improve consumer welfare.

Related Literature. This paper is closely related to the literature on signaling quality through prices and advertising. Milgrom and Roberts (1986) study a dynamic monopoly model in which both price and advertising can signal quality. If quality is positively correlated with costs, high prices along with dissipative advertising are used to signal quality. Low prices are used, instead, when good-quality producers are more efficient. Bagwell and Riordan (1991) show that high (and declining) prices signal quality, in a static monopoly model for durable goods, with a fraction of informed consumers. Lower sales due to high prices are less damaging to the good quality producer since it has higher marginal costs. Linnemer (2002) extends this model by including advertising, obtaining that both high prices and dissipative advertising are interpreted as signals of quality by uninformed consumers. Our model is most closely related to Judd and Riordan (1994) and Bar-Isaac (2003). In Judd and Riordan (1994) consumers learn from both their own experience and the price. Therefore only a high-type monopolist will signal good quality through a high price because he knows that consumers have some corroborating information about the product. Finally, Bar-Isaac (2003) studies a dynamic model, in which a monopolist signals quality through its decision to trade or not, and consumers learn by observing ex-post outcomes. In equilibrium, good firms never stop selling, while bad firms, which use a mixed strategy, still sell with positive probability. Our main contribution is to allow the monopolist to signal quality through strategic prices, which in turn affect the information transmitted to second-period consumers through the observation of past purchases.

Our work is also closely related to the social learning literature, in which consumers learn about product quality by observing past purchase decisions. Banerjee (1992) and Bikhchandani, Hirshleifer and Welch

(1992) introduced the concept of informational cascades in models of Bayesian learning. Bose et al. (2006; 2008) endogenize the herding process by allowing for strategic pricing in a monopoly market in which consumers learn about quality from both private signals and past purchases. In their model prices are used not only to extract rent, but also to screen consumers' private information about quality. They show that high initial prices allow the monopolist to learn more quickly about the consumer's private information, therefore being used in the early stages of a product life cycle. In the long run, an informational cascade may occur, in which the monopolist serves the whole market or rather exit (by charging an extremely low or high price, respectively). In the strategic experimentation literature, where both firms and consumers are initially uncertain about product quality, prices serve as instruments to influence the learning process. Here, firms optimally choose prices in order to incentivize experimentation and information acquisition, both by consumers and themselves (see, for example, Bergemann and Valimaki (1996), Caminal and Vives (1999), Schlee (2001)). In our work, firms have a signaling motive since they have (imperfect) information about the product they sell. Moreover, with a general demand function, we show that it is not necessarily the case that information transmission is accelerated through high prices, as in Bose et al. (2006,2008).

The monopolist can also influence the herding process through the launch strategy as in Sgroi (2002), Liu and Schiraldi (2012) and Bhalla (2013). They find that the optimal launch strategy is a sequential selling scheme that allows the firm to spread out information by letting subsequent consumers observe past purchase history. In particular, firms benefit from allowing a set of "guinea pigs" to make purchases before the rest of the market. Aoyagi (2010) analyzes the same problem as Bhalla (2013) with the main difference that buyers have interdependent values for the good for sale. He shows that a sequential sale scheme, in which the monopolist trades with one buyer at the time, is optimal. Finally the choice of having a product tested before launching it might also been used as potential instruments to influence social learning (Taylor, 1999; Gill and Sgroi, 2012). In our paper, first-period consumers play a crucial role, as in Sgroi (2002). Nevertheless, we allow for private information on the firm side, so that prices both signal quality to second-period consumers and determine the amount of information they receive by driving early-adopters' purchase decisions.

The paper proceeds as follows. In section 2 we introduce the model. In section 3 we present the main results. In section 4 we illustrate them through two examples and in section 5 we analyze the welfare implications of the previous results. Finally, in section 6 we conclude.

2 The Model

We consider a two-period model, in which a long-lived monopolist faces a (representative) short-lived consumer each period. Product quality - the match between the product's features and consumers' tastes - can be good or bad, $q \in \{0, 1\}$. The monopolist is privately informed about his type, the probability of producing good-quality products, which can be either high or low, $\theta \in \{L, H\}$[4]. We assume that marginal costs are zero, there is no discounting and the monopolist's decision variable is the selling price. First-period consumers are early adopters who learn the quality of the product even before purchasing it. Second-period consumers, on the other hand, are initially uninformed about quality, which they infer by observing the public history, that is first-period price and purchase decisions.

The timing of the game is as follows: the monopolist learns θ and chooses the introductory price P. Early adopters observe P, product quality q, and make a purchase decision. Second-period consumers update beliefs about q after observing P and early adopters' purchase decision. Given second-period price, they decide whether to buy or not. Second-period profits are realized and the game ends.

In $t = 1$, there is a fraction λ of early adopters, knowledgeable about the industry, which for simplicity is assumed to be perfectly informed about quality $q \in \{0, 1\}$[5]. They receive a payoff of $f(q, v) - P$ from buying and zero otherwise. The utility $f(q, v)$ is an increasing function of the product's quality q and an idiosyncratic shock v, an independent draw from distribution $G(v)$. They buy if and only if $f(q, v) - P \geq 0$, which leads to a demand $\overline{D}(P, q) = \mathbb{P}(\{v | f(q, v) - P \geq 0\})$, decreasing in P and increasing in q[6]. First-period expected demand is then given by:

$$D(\theta, P) = \theta \overline{D}(P, 1) + (1 - \theta) \overline{D}(P, 0) \tag{1}$$

Second-period consumers get a payoff $q - P_2$ from buying and zero otherwise. They are initially uninformed about q, which they learn after observing the introductory price P and early adopters' decision to buy or not, $d \in \{Y, N\}$. In particular, they infer the monopolist's type from prices (in a separating equilibrium). Similarly they imperfectly learn (due to the idiosyncratic shock v) the actual realization of quality from early adopters' purchase decision. After observing P, they update their beliefs from μ_0 to $\mu := \mathbb{P}(q = 1|P)$.[7] Then,

[4]We consider persistent types, which avoids the need to deal with repeated signaling. A monopolist of type θ produces a good-quality product with probability θ, which is then sold in both periods.

[5]Our results can be generalized to the case in which early adopters are imperfectly informed about quality - for example, they receive a binary signal about quality.

[6]Since purchases are influenced by idiosyncratic preferences, early adopters might be interested in buying not only good, but also bad-quality products.

[7]Note that separating prices (P^L, P^H) induce beliefs $\mu = L$ if $P = P^L$ and $\mu = H$ if $P = P^H$. On the other hand, pooling prices do not provide any information leading to $\mu = \mu_0$. Moreover we restrict off-the-equilibrium path beliefs such that any

after observing early adopters' purchase decision d, they update beliefs to $\mu^d(P,\mu)$, given by:

$$\mu^Y(P,\mu) = \frac{\mu \overline{D}(P,1)}{\mu \overline{D}(P,1) + (1-\mu)\overline{D}(P,0)}$$
$$\mu^N(P,\mu) = \frac{\mu\left[1-\overline{D}(P,1)\right]}{\mu\left[1-\overline{D}(P,1)\right] + (1-\mu)\left[1-\overline{D}(P,0)\right]}$$

They buy if and only if $\mu^d(P,\mu) - P_2 \geq 0$, which leads to optimal second-period prices $P_2 = \mu^d(P,\mu)$ that allow for full rent extraction[8].

Let $\Pi(\theta, P, \mu)$ denote the expected profits of a monopolist of type θ who charges the price P in the first period, inducing beliefs μ after signaling:

$$\Pi(\theta, P, \mu) = \lambda P D(\theta, P) + D(\theta, P)\mu^Y(P,\mu) + (1 - D(\theta, P))\mu^N(P,\mu) \quad (2)$$

We define and analyze conditions for the existence of separating equilibria in pure strategies and show that signaling can occur through both high and low prices. We finally provide an example for each case and discuss consumers' welfare under the two alternative equilibria we found.

3 Separating Equilibria

To analyze the role of prices as signals of quality, we focus on separating equilibria. As types are persistent, signaling occurs only in the first period. Nevertheless, first-period consumers, being perfectly informed about quality, do not rely on price information when deciding whether to buy or not. Signaling is relevant for second-period consumers, who infer product quality both from first-period prices and early adopters' purchase decisions. Separating prices $\left(P^L, P^H\right)$ induce beliefs $\mu = L$ if $P = P^L$ and $\mu = H$ if $P = P^H$. Moreover, off-equilibrium prices $P \neq \left\{P^L, P^H\right\}$ are assumed to induce pessimistic beliefs $\mu = L$.

Definition 1. A (first-period) separating equilibrium is a pair $\left(P^L, P^H\right)$ such that:

C1. $\Pi\left(L, P^L, \mu = L\right) \geq \Pi(L, P, \mu = L)$, for every $P \neq P^H$.

deviation is attributed to the low-type monopolist.

[8] Our results are robust to the alternative specification of the model, in which second-period consumers have an elastic demand, making full extraction impossible. In this case we only need to impose convexity of the monopolist's second period profit with respect to beliefs (satisfied for example when demand is linear).

C2. $\Pi\left(L, P^{L}, \mu=L\right) \geq \Pi\left(L, P^{H}, \mu=H\right)$, and

C3. $\Pi\left(H, P^{H}, \mu=H\right) \geq \Pi\left(H, P, \mu=L\right)$, for every $P \neq P^{H}$.

For the low-type monopolist, the equilibrium price P^{L} must dominate any price $P \neq P^{H}$ that induces the same pessimistic beliefs (C1). Moreover, the low-type monopolist should not have incentives to mimic the high-type one, even if this implies optimistic beliefs (C2). Finally, for the high-type monopolist, P^{H} must dominate any other price P, knowing that any deviation will be treated as coming from a low-type seller (C3). Therefore a separating equilibria can be characterized as in the next lemma, which we use in the analysis.

Lemma 2. Prices $\left(P^{L}, P^{H}\right)$ constitute a separating equilibrium if and only if $P^{L}=P^{L^{*}}$, and they satisfy

- $\Pi\left(L, P^{L^{*}}, \mu=L\right) \geq \Pi\left(L, P^{H}, \mu=H\right)$
- $\Pi\left(H, P^{H}, \mu=H\right) \geq \Pi\left(H, P^{H^{*}}, \mu=L\right)$

where $P^{L^{*}}$ maximizes low-type monopolist's expected profits, $\Pi\left(L, P, \mu=L\right)$ (the low-type full-information monopoly price), and $P^{H^{*}}$ maximizes high-type monopolist's expected profits under beliefs $\mu=L$, $\Pi\left(H, P, \mu=L\right)$.

3.1 Existence and Characterization of Separating Equilibria

We now look for separating equilibria as defined above, and apply the intuitive criterion refinement (Cho and Kreps, 1987) to eliminate implausible off-equilibrium beliefs. As shown in Lemma 2, in any separating equilibrium, the low-type monopolist cannot do better than behave as in the complete-information setting. Thus if the high-type monopolist is to separate, he must choose a price that the low-type one would not mimic (and from which he would not deviate). To focus on the case in which signaling is costly, we assume that the full-information monopoly price for the high type $P^{H^{**}}$ would be mimicked by a low type, or equivalently $\Pi\left(L, P^{H^{**}}, \mu=H\right)>\Pi\left(L, P^{L^{*}}, \mu=L\right)$[9].

[9] The high-type full-information monopoly price is defined as the price that maximizes high-type monopolist's expected profits under correct beliefs $\mu=H$, $\Pi\left(H, P, \mu=H\right)$.

Definition 3. Our first result shows that the high-type monopolist can signal its type either through a high or low introductory price (with respect to the full-information monopoly price), depending on the elasticities of both demand and beliefs with respect to prices. We first define separation through high or low prices. Separation occurs through high (low) prices if the high-type monopolist's equilibrium price is higher (lower) than its full-information monopoly price, $P^H > (<) P^{H^{**}}$.

The possibility of separation is, as usual, related to the existence of an action that is marginally less costly for high types. In this setting, however, we also require that consumers' beliefs have a marginally higher impact on profits for the high-type monopolist.

Lemma 4. If two single-crossing properties

(SCP1) $\frac{\partial^2 \Pi(\theta,P,\mu)}{\partial\theta\partial P} > (<)\, 0$

(SCP2) $\frac{\partial^2 \Pi(\theta,P,\mu)}{\partial\theta\partial \mu} > 0$

are satisfied, there exists an equilibrium $\left(P^{L^*}, P^H\right)$ in which separation occurs through high (low) prices. Moreover, in the only equilibrium that satisfies the intuitive criterion, the price charged by the high-type monoplist is the least costly among the ones that induce separation, i.e. $P^H = \bar{P}$, where $\bar{P}$ satisfies

$$\Pi\left(L, \overline{P}, \mu = H\right) = \Pi\left(L, P^{L^*}, \mu = L\right).$$

As shown in Figure 1, the existence of a separating equilibrium in which high (low) prices signal quality is implied by SCP1 and SCP2. Note first that SCP1 implies directly that $P^{H^*} > (<) P^{L^*}$. When allowed to choose the optimal price, the high-type monopolist will prefer to set a higher (lower) price than his low-type counterpart, holding beliefs constant. This is so because higher (lower) prices are marginally less costly for the high-type monopolist. SCP1 also implies that the cost of signaling through high (low) prices is lower for the high-type monopolist. Since beliefs affect firm's profits in a non-separable way, an additional assumption is needed to guarantee separation. SCP2 implies that the shift from pessimistic to optimistic beliefs is more attractive to the high type firm.

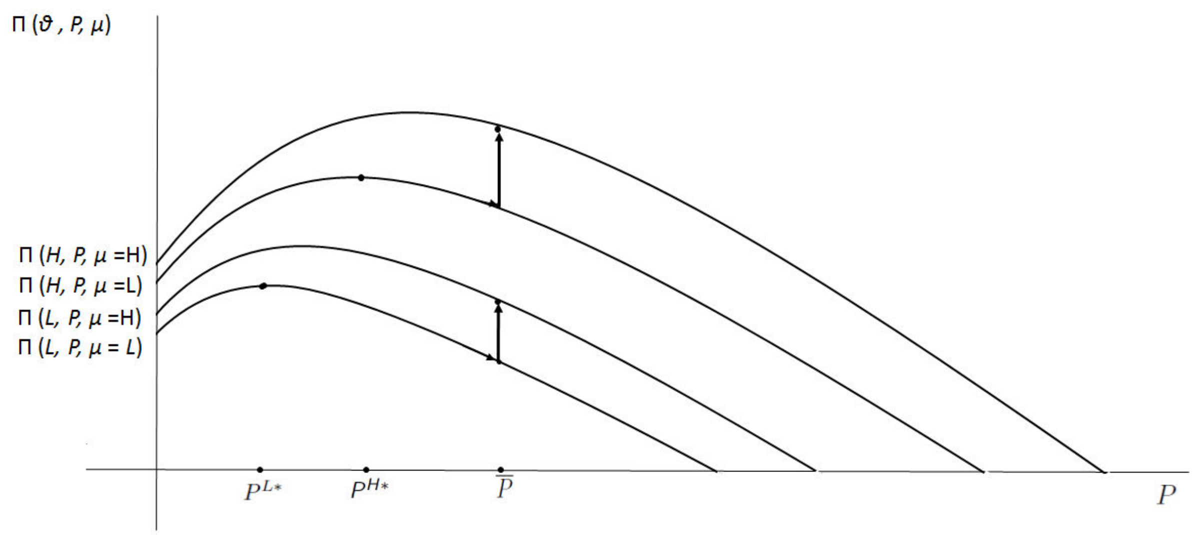

Figure 1: Separation through high prices.

SCP1 is the standard single-crossing property from the signaling literature (Spence, 1973). SCP2 is automatically satisfied in a big majority of models due to the quasilinear structure of the utility function[10]. Here, we impose that higher beliefs are more valuable to higher types, allowing separation to arise. Note, however, that these are sufficient conditions, and separation could still exist under less restrictive assumptions, even though it makes the economic analysis and interpretation more complex.

We now analyze conditions - on the primitives of the model - such that SCP1 and SCP2 are simultaneously satisfied. To keep the discussion simple, consider separation through high prices. SCP1 is given by

$$\begin{aligned}\frac{\partial^2 \Pi(\theta, P, \mu)}{\partial\theta\partial P} &= D_{\theta P}(\theta, P)\left[P + \mu^Y(P,\mu) - \mu^N(P,\mu)\right] \\ &+ D_\theta(\theta, P)\left[\lambda + \left(\frac{\partial \mu^Y(P,\mu)}{\partial P} - \frac{\partial \mu^N(P,\mu)}{\partial P}\right)\right]\end{aligned}$$

Prices have both a static and dynamic effect on profits. The static effect is driven by the elasticity of (first-period) demand. In particular, the condition $D_{\theta P} > 0$ ensures that demand for good-quality products is less elastic (relatively to bad-quality products), so that high-type firms, which are more likely to produce good-

[10]For example, in Spence's model, agents payoffs are given by $-c(e,\theta) + w(\mu)$, guaranteeing that higher beliefs are equally beneficial for all types θ.

quality, are marginally less affected by high prices. Similarly, the dynamic effect is driven by the elasticity of beliefs with respect to prices. First-period prices influence information transmission between early adopters and learners in the following way. A first-period sale leads to a jump up in beliefs, while the opposite is true if there are no sales. The difference between these two effects reflects the amount of information conveyed by early adopters' purchase decisions. If $\frac{\partial\mu^Y(P,\mu)}{\partial P} - \frac{\partial\mu^N(P,\mu)}{\partial P} \geq 0$, information transmission is higher at higher prices, so that sales at high prices carry good news to second-period consumers. In other words, the "good news" generated by first-period sales are complements with prices. Since an increase in P induces a bigger difference in beliefs between a history of sale and one of no-sale, and a high-type monopolist is more likely to sell, a higher price is informationally more advantageous for the high-type monopolist.

Proposition 5. Sufficient conditions for the existence of a separating equilibrium $\left(P^{L^*}, P^H\right)$ wherein $P^H > P^{H^{**}}$ are

1. $D_{\theta P} > 0$
2. $\frac{\partial\mu^Y(P,\mu)}{\partial P} - \frac{\partial\mu^N(P,\mu)}{\partial P} \geq 0$
3. $\frac{\partial\mu^Y(P,\mu)}{\partial \mu} - \frac{\partial\mu^N(P,\mu)}{\partial \mu} \geq 0$.

The analysis is analogous for separation through low prices. Specifically, if demand for good-quality products is more elastic, $D_{\theta P} < 0$, then low prices are less detrimental to high-type firms, more likely to produce good-quality products. Moreover, beliefs are more sensitive to early adopters' purchase decisions at lower prices. We impose a slightly more stringent condition. We require that "good news" and prices are substitutes, and that this effect dominates the standard advantage of a high-type monopolist in raising prices given by a bigger number of inframarginal consumers in the first period[11].

Proposition 6. Sufficient conditions for the existence of a separating equilibrium $\left(P^{L^*}, P^H\right)$ wherein $P^H < P^{H^{**}}$ are

1. $D_{\theta P}(\theta, P) < 0$

[11] Note that this is a small added requirement when early adopters are few in number (as one can expect in a typical market).

2. $\frac{\partial \mu^Y(P,\mu)}{\partial P} - \frac{\partial \mu^N(P,\mu)}{\partial P} \leq -\lambda$

3. $\frac{\partial \mu^Y(P,\mu)}{\partial \mu} - \frac{\partial \mu^N(P,\mu)}{\partial \mu} \geq 0$.

We now show that both the static and dynamic channels through which a monopolist can signal its type depend on the relative elasticity of demand between good and bad quality products. If the demand for good-quality products is less elastic, both the static and dynamic effect of prices on profits lead to high prices as a signaling tool. On the one hand, the high-type monopolist suffers less from charging high prices since it loses less consumers than a bad-quality producer. More interestingly, lower demand elasticity also implies that early adopters' purchase decisions are more informative at higher prices. In fact, at high prices good-quality products sell more often than bad-quality ones, which in turn leads to better news about quality when, in spite of such high prices, there is a sale. The opposite happens when elasticity is higher for good-quality products. Now it is sales at low prices which imply higher inferences about a product's quality.

Corollary 7. Suppose that $\mu\bar{D}(P,1) + (1-\mu)\bar{D}(P,0) \leq \frac{1}{2}$. Then

1. $D_{\theta P} > 0$ implies $\frac{\partial \mu^Y(P,\mu)}{\partial P} - \frac{\partial \mu^N(P,\mu)}{\partial P} \geq 0$

2. $D_{\theta P} < -\lambda \frac{\mu}{1-\mu}$ implies $\frac{\partial \mu^Y(P,\mu)}{\partial P} - \frac{\partial \mu^N(P,\mu)}{\partial P} \leq -\lambda$.

4 Examples

4.1 Low prices signal quality: incremental innovation

Consider an environment in which good-quality products ($q = 1$) have access to a bigger market than bad-quality ones ($q = 0$). We can think of a firm introducing a new product, which can be of either good or bad quality. In the case of bad quality, only consumers already identified with the brand will be interested in buying it by switching from the older version to the new one. However, good-quality products will appeal to a broader consumer base, including those who have been purchasing from a different firm in the past. This fact can be summarized by an assumption on the demand function:

Assumption. $\bar{D}(P,1) = \alpha \bar{D}(P,0)$ with $\alpha > 1$.

Note that $D_{\theta P} < 0$, because high-type firms, that have access to a broader market, lose more consumers when prices increase. Moreover, beliefs generated by a first-period sale do not change with prices ($\frac{\partial \mu^Y}{\partial P} = 0$), which in turn implies $\frac{\partial \mu^Y}{\partial P} - \frac{\partial \mu^N}{\partial P} \leq 0$. Information transmission is muted when prices increase. Since both the demand for good and bad-quality products are proportional, first-period sales at higher prices have no impact on beliefs. Two simple parametric conditions imply that conditions in Proposition 6 are satisfied.

Corollary 8. If $\frac{1-H}{H} \frac{|\bar{D}_P(P,0)|}{\max\{\alpha-1,1\}} > \lambda$ and $\alpha \left[\frac{H}{1-H}\right]^2 \leq 1$, separation occurs through low prices.

Therefore, a market where good quality is intended as bigger consumer base, is characterized by separation through low prices. In particular, low prices are more costly for a low-type monopolist, both because of a lower (average) elasticity, and the fact that the "no sale" event (more likely at high prices) is the only event that carries information about quality. A penetration pricing strategy can therefore characterize the introduction of incremental innovations.

4.2 High prices signal quality: disruptive innovation

Consider now a firm introducing a potentially drastic new innovation that, if successful, would disrupt the market. Such a good quality innovation would make a proportion $(1-\alpha)$ of consumers completely price inelastic. This can be modelled as

Assumption. $\bar{D}(P,1) = (1-\alpha) + \alpha \bar{D}(P,0)$.

It is easy to see that in this case $D_{\theta P} > 0$, since a high-type firm, more likely to produce a good-quality product, will face less elastic consumers. In this case, not selling at relatively high prices has no impact on consumers' perception of quality ($\frac{\partial \mu^N}{\partial P} = 0$). Then it follows that $\frac{\partial \mu^Y}{\partial P} - \frac{\partial \mu^N}{\partial P} \geq 0$. Information transmission is higher at high prices: sales at high prices carry good news to second-period consumers due to the presence of a fraction of inelastic demand for good-quality products. A simple parametric conditions imply that conditions in Proposition 5 are satisfied.

Corollary 9. If $\alpha \left[\frac{H}{1-H}\right]^2 \leq \frac{\underline{D}}{1-\alpha+\alpha\underline{D}}$, where $\underline{D} = \inf_P \bar{D}(P,0)$, separation occurs through high prices.

Here, a market where quality implies a fraction of more inelastic consumers, leads to separation through high prices. A high-type monopolist is then, obviously, more willing to increase prices to extract rent. Moreover, sales at higher prices amplify good news about product quality, which in turn reinforce the static revenue effect. A skimming pricing strategy can therefore characterize the introduction of disruptive innovations.

5 Consumer welfare

We now analyze how the presence of early adopters affect consumer welfare. By considering a benchmark in which past purchase decisions are not observable[12], we find that learning from past purchase decisions increases (decreases) welfare when separation occurs through high (low) prices. Basically, the observability of early adopters' purchase decisions makes separation easier, leading to lower signaling costs for the high-type monopolist. This is beneficial for consumers when costly separation involves high prices, but detrimental for them when separation is achieved through low prices.

In particular, the high type benefits more than the low type from information diffusion, which is only possible through the observability of early adopters' purchase decisions. This implies a lower cost of price signaling for the high-type monopolist. Welfare implications are different, however, depending on whether separation occurs through high or low prices. Learning from past purchases improves welfare if high prices signal quality, since the distortion created by such high prices (perfect competition would have $P = 0$) is smaller than in the benchmark case. The opposite is true when low prices are used, since costly separation mitigates the high prices introduced by monopoly power[13].

Therefore, separation is less costly for the high-type monopolist when early-adopters allow information transmission. When separation occurs through high prices, a higher cost of signaling implies higher prices, which are more detrimental for first-period consumers. On the other hand, when separation occurs through low prices, a higher cost of signaling translates into lower prices which improve consumer welfare.

Consider the benchmark case in which early adopters are perfectly informed about quality, but their purchase decisions are not observable by second-period consumers, who can only rely on prices to infer the monopolist's type (and therefore product quality). First-period demand is given by $D(P,\theta)$, but now second-

[12] It is worth noting that early adopters make separation possible. Indeed, in the benchmark case with no early adopters - or equivalently, with uninformed consumers in both periods - there is no separating equilibrium.

[13] Note that second-period consumer welfare is not involved in the comparison since the monopolist fully extracts the surplus.

period beliefs are such that $\mu^Y(P,\mu) = \mu^N(P,\mu) = \mu$. Consumers learn about the monopolist's perception of quality, but not about the match between the product's characteristics and their needs, since they do not have access to early adopters' knowledge. This leads to profits of the form

$$\Pi(\theta, P, \mu) = P \cdot D(\theta, P) + \mu \tag{3}$$

Note that SCP2 is directly satisfied, $\frac{\partial^2 \Pi(\theta,P,\mu)}{\partial\theta\partial\mu} = 0$. Separation then depends on SCP1, and we have $\frac{\partial^2 \Pi(\theta,P,\mu)}{\partial\theta\partial P} = PD_{\theta P}(\theta, P)$. Therefore in this benchmark SCP1 is less positive (negative) when separation is achieved through high (low) prices, which in turn implies a higher effort for the high-type monopolist to successfully separate from the low-type one. When separation is achieved through high prices, prices must be even higher when informed consumers's actions are not observable, thus lowering consumers' welfare. On the other hand, when separation occurs through low prices, non-observability leads to separation with even lower prices, increasing consumer welfare.

6 Conclusion

This paper studies the optimal introductory price for a new product in a dynamic monopoly model in which consumers learn through both prices and early adopters' purchase decisions. Quality is intended as the match between product's features and consumers' needs and tastes. The firm is privately informed about his type, the probability of producing good-quality products (products consumers are more likely to like, given their specific characteristics). Nevertheless only early adopters can perfectly ascertain product quality before buying the product. Second-period consumers learn quality by observing the public history, namely past price and early adopters' purchase decisions. Prices here play a two-fold role: they act as signals of the firm's type but they also facilitate (or impede) information transmission between consumers' generations. Our main result is that signaling can occur through both high and low prices, depending on the elasticity of early adopters' demand. In particular, demand elasticity operates through two main signaling channels, both static and dynamic. If demand for good-quality products is less elastic (relatively to bad-quality products), high-type firms, which are more likely to produce good-quality, are marginally less affected by high prices. Similarly, since a higher price induces a bigger difference in beliefs between a history of sale and one of no-sale, and a high-type monopolist is more likely to sell, a higher price is informationally more advantageous for the high-type monopolist. The opposite reasoning is true for the case in which good-quality products are characterized by higher demand elasticity.

Our work sheds new light on skimming v/s penetration pricing strategies, as well as rationalise business strategies as Apple's switching from high to low prices. We also provide two examples of markets where our prediction could be applied, and show that in the case of disruptive (incremental) innovations high (low) prices can be used as signals of quality. We finally argue that the existence of early adopters benefit markets in that allow firms to signal its quality. Moreover, the observability of early adopters' choices may improve welfare in markets where quality is intended as bigger consumer base.

Several extensions can be derived from this two-period framework. First of all, it would be interesting to consider the case in which firms could offer a special deal to early adopters in order to manipulate their purchase decisions, and in turn information transmission to second-period consumers. Moreover, learning from both early adopters' purchase decisions and reviews (WOM) could give new insignts on the optimal pricing strategy. Finally competition among two firms could lead to interesting price dynamics.

Appendix

Proof of Lemma 2. A necessary condition for C1 to be satisfied is that the low-type monopolist charges in equilibrium the full-information monopoly price P^{L^*}. Moreover C3 requires that the high-type monopolist should not have any incentive to deviate from the equilibrium price, as such deviation implies pessimistic beliefs. Then it is sufficient to control for the best deviation, which occurs at P^{H^*}, the maximizer of $\Pi(H, P, \mu = L)$. ■

Proof of Lemma 4. We consider two candidates for separating equilibrium. The first one involves separation through high prices, and the second one separation thorugh low prices. In both cases we define a price $P^H = \overline{P}$ (higher and lower than $P^{H^{**}}$, respectively) such that the low-type monopolist is indifferent between following the equilibrium strategy and mimicking the high-type one:

$$\Pi\left(L, \overline{P}, \mu = H\right) - \Pi\left(L, P^{L^*}, \mu = L\right) = 0$$

A separating equilibrium exists if at the price $\overline{P}$ the high-type monopolist has no incentive to deviate:

$$\Pi\left(H, \overline{P}, \mu = H\right) - \Pi\left(H, P^{H^*}, \mu = L\right) \geq 0 = \Pi\left(L, \overline{P}, \mu = H\right) - \Pi\left(L, P^{L^*}, \mu = L\right). \tag{4}$$

For 4 to be satisfied, the following two conditions are sufficient:

$$\Pi\left(H, \overline{P}, \mu = L\right) - \Pi\left(H, P^{H^*}, \mu = L\right) \geq \Pi\left(L, \overline{P}, \mu = L\right) - \Pi\left(L, P^{L^*}, \mu = L\right) \tag{5}$$

$$\Pi\left(H, \overline{P}, \mu = H\right) - \Pi\left(H, \overline{P}, \mu = L\right) \geq \Pi\left(L, \overline{P}, \mu = H\right) - \Pi\left(L, \overline{P}, \mu = L\right) \tag{6}$$

which are directly implied by SCP1 and SCP2. We now show that $\left(P^{L^*}, \overline{P}\right)$ is the only equilibrium that satisfies the intuitive criterium. An equilibrium fails the intuitive criterion if there exists a price P' such that: a) $\Pi\left(H, P', \mu = H\right) \geq \Pi\left(H, P^H, \mu = H\right)$ and b) $\Pi\left(L, P', \mu = H\right) < \Pi\left(L, P^{L^*}, \mu = L\right)$. That is, if there exists a price P' such that the high type is better off by deviating and the low type makes more profits following the equilibrium strategy, even if the deviation would have generated optimistic beliefs. Intuitively, if such a price P' exists, consumers should interpret such a deviation as coming from a high-type seller, collapsing the equilibrium. We prove the result for the case in which separation occurs through high prices. The proof consists of two steps. We first show that there is no equilibrium price $P > \overline{P}$ that satisfies the intuitive criterion. Consider the price $P > \overline{P}$ such that $\left(P^{L^*}, P\right)$ is a separating equilibrium. Define $P^{'} = P - \varepsilon$. Then it is easy to see that a) $\Pi\left(H, P^{'}, \mu = H\right) \geq \Pi\left(H, P, \mu = H\right)$ and b) $\Pi\left(L, P^{'}, \mu = H\right) < \Pi\left(L, P^{L^*}, \mu = L\right)$. Noting that $P^{H^{**}} < \overline{P}$ (signaling is costly), it follows that $P^{H^{**}} < P^{'} < P$. Therefore $\Pi\left(H, P^{'}, \mu = H\right) \geq \Pi\left(H, P, \mu = H\right)$. Moreover we know that $\Pi\left(L, P, \mu = H\right) < \Pi\left(L, P^{L^*}, \mu = L\right)$. Then by continuity $\Pi\left(L, P^{'}, \mu = 1\right) < \Pi\left(L, P^{L^*}, \mu = 0\right)$. Thus for any price $P < \overline{P}$ condition a) is not satisfied, violating the intuitive criterion. We now show that $\left(P^{L^*}, \overline{P}\right)$ is the only separating equilibrium that satisfies the intuitive criterion. If $P^{'} > \overline{P}$, condition a) is not satisfied. Then, $P^{'} \geq \overline{P}$. But if $P^{'} < \overline{P}$, there is no separating equilibrium, since any deviation at $P^{'} < \overline{P}$ is profitable for the low-quality seller. Then it must be $P^{'} = \overline{P}$, and $\left(P^{L^*}, \overline{P}\right)$ is the only separating equilibrium that satisfies the intuitive criterion. ■

Proof of Proposition 5. We first analyze SCP1:

$$\begin{aligned}\frac{\partial^2 \Pi\left(\theta, P, \mu\right)}{\partial\theta\partial P} &= D_{\theta P}\left(\theta, P\right)\left[P + \mu^Y\left(P, \mu\right) - \mu^N\left(P, \mu\right)\right] \\ &+ D_{\theta}\left(\theta, P\right)\left[\lambda + \left(\frac{\partial\mu^Y\left(P, \mu\right)}{\partial P} - \frac{\partial\mu^N\left(P, \mu\right)}{\partial P}\right)\right]\end{aligned}$$

Since $D_{\theta}\left(\theta, P\right) = \overline{D}\left(P, 1\right) - \overline{D}\left(P, 0\right) > 0$, Condition 1 and 2 imply the result. Consider now SCP2:

$$\frac{\partial^2 \Pi\left(\theta, P, \mu\right)}{\partial\theta\partial\mu} = D_{\theta}\left(\theta, P\right)\left(\frac{\partial\mu^Y\left(P, \mu\right)}{\partial\mu} - \frac{\partial\mu^N\left(P, \mu\right)}{\partial\mu}\right)$$

Since $D_{\theta}\left(\theta, P\right) > 0$, therefore $\frac{\partial\mu^Y(P,\mu)}{\partial\mu} - \frac{\partial\mu^N(P,\mu)}{\partial\mu} \geq 0$ is a sufficient condition for SCP2 to be satisfied. ■

Proof of Proposition 6. Analogous to Proof of Proposition 5.■

Proof of Corollary 7. Consider separation through high prices ($D_{\theta P} > 0$). Condition $\frac{\partial\mu^Y(P,\mu)}{\partial P} \geq \frac{\partial\mu^N(P,\mu)}{\partial P}$, is equivalent to:

$$\frac{\left[\overline{D}_P\left(P,1\right)\overline{D}\left(P,0\right) - \overline{D}_P\left(P,0\right)\overline{D}\left(P,1\right)\right]}{\left[\mu\overline{D}\left(P,1\right) + \left(1-\mu\right)\overline{D}\left(P,0\right)\right]^2} \geq \frac{\left\{\left[\overline{D}_P\left(P,1\right)\overline{D}\left(P,0\right) - \overline{D}_P\left(P,0\right)\overline{D}\left(P,1\right)\right] + \left[\overline{D}_P\left(P,0\right) - \overline{D}_P\left(P,1\right)\right]\right\}}{\left[\mu\left(1-\overline{D}\left(P,1\right)\right) + \left(1-\mu\right)\left(1-\overline{D}\left(P,0\right)\right)\right]^2}$$

$$\left[\overline{D}_P(P,1)\,\overline{D}(P,0)-\overline{D}_P(P,0)\,\overline{D}(P,1)\right]\left[\mu\left(1-\overline{D}(P,1)\right)+(1-\mu)\left(1-\overline{D}(P,0)\right)\right]^2$$

$$\geq\left[\overline{D}_P(P,1)\,\overline{D}(P,0)-\overline{D}_P(P,0)\,\overline{D}(P,1)\right]\left[\mu\overline{D}(P,1)+(1-\mu)\,\overline{D}(P,0)\right]^2$$

$$+\left[\overline{D}_P(P,0)-\overline{D}_P(P,1)\right]\left[\mu\overline{D}(P,1)+(1-\mu)\,\overline{D}(P,0)\right]^2$$

Note that $\left[\overline{D}_P(P,0)-\overline{D}_P(P,1)\right]<0$ since $D_{\theta P}>0$. Therefore a sufficient condition is given by

$$\mu\left(1-\overline{D}(P,1)\right)+(1-\mu)\left(1-\overline{D}(P,0)\right)\geq\mu\overline{D}(P,1)+(1-\mu)\,\overline{D}(P,0)$$

$$\mu\bar{D}(P,1)+(1-\mu)\bar{D}(P,0)\leq\frac{1}{2}$$

Then consider separation through low prices ($D_{\theta P}<0$). Condition $\frac{\partial\mu^Y(P,\mu)}{\partial P}-\frac{\partial\mu^N(P,\mu)}{\partial P}\leq-\lambda$, is equivalent to:

$$\lambda+\frac{\mu(1-\mu)\left[\overline{D}_P(P,1)\,\overline{D}(P,0)-\overline{D}_P(P,0)\,\overline{D}(P,1)\right]}{\left[\mu\overline{D}(P,1)+(1-\mu)\,\overline{D}(P,0)\right]^2}$$

$$\leq\frac{\mu(1-\mu)\left\{\left[\overline{D}_P(P,1)\,\overline{D}(P,0)-\overline{D}_P(P,0)\,\overline{D}(P,1)\right]+\left[\overline{D}_P(P,0)-\overline{D}_P(P,1)\right]\right\}}{\left[\mu\left(1-\overline{D}(P,1)\right)+(1-\mu)\left(1-\overline{D}(P,0)\right)\right]^2}$$

Noting that

$$\frac{\mu(1-\mu)\left[\overline{D}_P(P,1)\,\overline{D}(P,0)-\overline{D}_P(P,0)\,\overline{D}(P,1)\right]}{\left[\mu\overline{D}(P,1)+(1-\mu)\,\overline{D}(P,0)\right]^2}\leq\frac{\mu(1-\mu)\left[\overline{D}_P(P,1)\,\overline{D}(P,0)-\overline{D}_P(P,0)\,\overline{D}(P,1)\right]}{\left[\mu\left(1-\overline{D}(P,1)\right)+(1-\mu)\left(1-\overline{D}(P,0)\right)\right]^2}$$

holds if $\mu\bar{D}(P,1)+(1-\mu)\bar{D}(P,0)\leq\frac{1}{2}$ we just need to verify that

$$\lambda\leq\frac{\mu(1-\mu)\left[\overline{D}_P(P,0)-\overline{D}_P(P,1)\right]}{\left[\mu\left(1-\overline{D}(P,1)\right)+(1-\mu)\left(1-\overline{D}(P,0)\right)\right]^2}$$

which is implied by

$$\lambda \leq \frac{\mu (1-\mu) \left[\overline{D}_P (P,0) - \overline{D}_P (P,1)\right] \mid}{\left(1-\overline{D}(P,0)\right)^2}$$

which in turn is implied by $D_{\theta P} < -\lambda \frac{\mu}{1-\mu}$. ■

Proof of Corollary 8. Given $\frac{\partial \mu^Y}{\partial P} = 0$, condition 2 in Proposition 6 is equivalent to

$$(\alpha - 1)\frac{1-\mu}{\mu}\frac{1}{\mu^{N2}(p)}\frac{|\bar{D}_P(P,0)|}{(1-\alpha\bar{D}(P,0))^2} > \lambda$$

which is implied by the parametric condition

$$\frac{1-H}{H}\frac{|\bar{D}_P(P,0)|}{\max\{\alpha-1,1\}} > \lambda$$

On the other hand, it is easy to see that the condition 3 in Proposition 6 is implied by

$$\alpha\left[\frac{H}{1-H}\right]^2 \leq 1 ■$$

Proof of Corollary 9. Direct from corollary 7 and $\bar{D}(P,1) = (1-\alpha) + \alpha\bar{D}(P,0)$. ■

References

[1] AOYAGI, M. (2010): “Optimal sales schemes against interdependent buyers”, *American Economic Journal: Microeconomics*, Vol. 2, No.1, pp. 150-182.

[2] BAGWELL, K. and M. RIORDAN (1991): “High and Declining Prices Signal Product Quality”, *The American Economic Review*, Vol. 81, No. 1, pp. 224-239.

[3] BANERJEE, A.V. (1992): “A simple model of herd behavior”, *Quarterly Journal of Economics*, Vol. 107, pp. 797–817.

[4] BAR-ISAAC, H. (2003): “Reputation and Survival: Learning in a Dynamic Signalling Model”, *Review of Economic Studies*, Vol. 70, pp. 231-251.

[5] BERGEMANN, J. and J. VALIMAKI (1996): “Learning and Strategic Pricing”, *Econometrica*, Vol. 64, pp. 1125-49.

[6] BERGEMANN, J. and J. VALIMAKI (1997): “Market Diffusion with Two-Sided Learning”, *The RAND Journal of Economics*, Vol. 28, No. 4, pp. 773-795.

[7] BHALLA, M. (2013): “Waterfall versus sprinkler product launch strategy: Influencing the herd”, *The Journal of Industrial Economics*, Vol. 61, No.1, pp. 138-165.

[8] BICKART, B. and R. SCHINDLER (2001): “Internet Forums as Influential Sources of Consumer Information”, *Journal of Interactive Marketing*, Vol. 15, No. 3, pp. 31–40.

[9] BIKHCHANDANI, S., HIRSHLEIFER, D. and I. WELCH (1992): “A theory of fads, fashion, custom, and cultural change as informational cascades”, *Journal of Political Economy*, Vol. 100, pp. 992–1026.

[10] BOSE, S., OROSEL, G.O., OTTAVIANI, M., VESTERLUND, L. (2006): “Monopoly pricing in the binary herding model”, *Economic Theory,* Vol. 37, pp. 203-241.

[11] BOSE, S., OROSEL, G.O., OTTAVIANI, M., VESTERLUND, L. (2008): “Dynamic monopoly pricing and herding”, *The Rand Journal of Economics,* Vol. 37, pp. 910–928.

[12] CAMINAL, R. and X. VIVES (1996): “Why Market Shares Matter: An Information-Based Theory”, Rand Journal of Economics, Vol. 27, pp. 221-239.

[13] CAMINAL, R. and X. VIVES (1999): “Price Dynamics and Consumer Learning”, Journal of Economics and Management Strategy, Vol 8, pp. 95-131.

[14] CHAMLEY, C. (2004): Rational Herds: Economic Models of Social Learning, Cambridge, University Press.

[15] CHO, I. and D. KREPS (1987): “Signaling Games and Stable Equilibria”, *The Quarterly Journal of Economics*, Vol. 102, No. 2, pp. 179-221.

[16] GILL, D. and D. SGROI (2008): “Sequential decisions with tests”, *Games and Economic Behavior*, Vol. 63, No. 2, pp. 663-678.

[17] GILL, D. and D. SGROI (2012): “The optimal choice of pre-launch reviewer”, *Journal of Economic Theory*, Vol. 147, No. 3, pp. 1247-1260.

[18] JUDD, K. and M. RIORDAN (1994): “Price and Quality in a New Product Monopoly”, *The Review of Economic Studies,* Vol. 61, No. 4, pp. 773-789.

[19] LINNEMER, L. (2012): "Dissipative advertising signals quality: Static model with a continuum of types", *Economics Letters*, Vol. 114, No.2, pp. 150-153.

[20] LIU, T., and P. SCHIRALDI (2012): "New product launch: herd seeking or herd preventing?", *Economic Theory*, Vol. 51, No. 3, pp. 627-648.

[21] MILGROM, P. and J. ROBERTS (1986): "Price and Advertising Signals of Product Quality", *Journal of Political Economy,* Vol. 94, No. 4, pp. 796-821.

[22] SCHLEE, E. (2001): "Buyer Experimentation and Introductory Pricing", *Journal of Economic Behavior and Organization,* Vol. 44, pp. 347-362.

[23] SGROI, D. (2002): "Optimizing Information in the Herd: Guinea Pigs, Profits, and Welfare", *Games and Economic Behavior*, Vol. 39, No. 1, pp. 137-166.

[24] TAYLOR, C. (1999): "Time-on-the-Market as a Sign of Quality", *The Review of Economic Studies,* Vol. 66, pp. 555-578.

[25] VETTAS, N. (1997): "On the Informational Role of Quantities: Durable Goods and Consumers' Word-of-Mouth Communication", International Economic Review, Vol. 38, pp. 915-944.