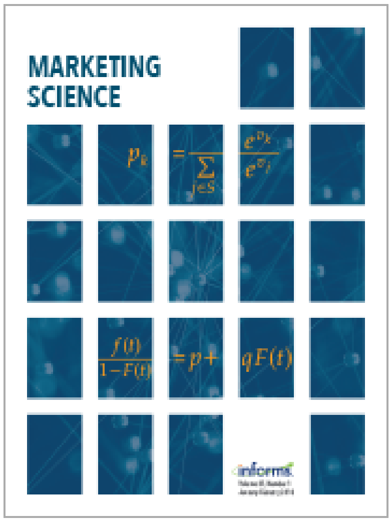

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Showrooming and Webrooming: Information Externalities Between Online and Offline Sellers

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Abstract. In a product market where consumers are open to uninformed purchases, we study competition between a traditional and an online retailer in the presence of showrooming. Several results are obtained. First, showrooming intensifies competition and lowers both firms' profits, thus supporting traditional and online retailers' recent strategy of carrying more exclusive varieties. Second, lowering consumer search costs may aggravate showrooming and decrease the traditional retailer's profits for intermediate search costs. Third, opening an online store expands the demand of the traditional retailer but intensifies competition, thus lowering its profits under certain conditions. Fourth, a return policy by the online retailer alleviates showrooming and relaxes competition but weakly reduces its demand, increasing its profits only for intermediate search costs. The return policy (weakly) increases the traditional retailer's profits. Fifth, when search cost is not high enough, price matching by the traditional retailer may also intensify competition and hurt its profits. We then examine how webrooming interacts with showrooming. When webrooming resolves partial match uncertainty, it may increase both firms' profits by inducing more consumers to participate.

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1. Introduction

The Internet facilitates a retail phenomenon called "showrooming": A consumer first visits a physical store to inspect a product and, if she likes it, buys it from an online seller at a lower price. Here the physical store fails to capture the sale but merely serves as a showroom for the online competitor. Common objects of showrooming include inspection goods such as appliances, books, clothes, digital devices, furniture, shoes, toys, etc. In the past decade, showrooming has posed a major challenge to traditional retailers such as Walmart, Best Buy, Macy's, Target, and Toys "R" Us (Zimmerman 2012).

Showrooming has drawn considerable managerial attention and precipitated several important industry practices. How does showrooming affect price competition between traditional and online retailers? Because some of the visitors to traditional retailers ultimately buy elsewhere online, traditional retailers are often viewed as victims and online retailers as winners of showrooming. Is this view always true? Traditional retailers have taken various measures in response to showrooming, including: (1) lowering consumer search costs via relocating stores, free parking or enhancing presale services;[1] (2) developing private labels and having suppliers to provide exclusive product lines that are not available elsewhere; (3) adding an online channel to stay price competitive and to attract online buyers; and (4) matching the prices of online retailers to better convert visitors into buyers. Are these strategies effective? If so, when? Today, many online retailers install a returns policy and also carry more varieties of exclusive products. In markets with potential showrooming, when do these measures increase the online retailer's profits? Besides showrooming, another type of information externality called "webrooming" also arises when consumers first assess certain product information online and then decide whether to visit a traditional retailer. How does webrooming affect cross-channel competition? We examine these questions in this paper.

In our baseline model, a traditional and an online retailer sell an identical inspection good. We consider categories with limited match uncertainty where consumers are willing to consider uninformed purchases (e.g., small consumer electronics and appliances, casual apparel, linen, outdoor or simple furniture, toys, etc.). Alternatively, each consumer may incur a search cost to visit the traditional retailer to discover match before deciding whether and where to buy. We assume consumers face heterogeneous hassle costs when buying from the online retailer.[2]

This simple model yields two results. First, the firms' profits are not monotone in search cost. The reason is that *search cost plays a dual role: It is the cost of buying from the traditional retailer and the cost of showrooming*. When search cost is low, all consumers visit the traditional retailer first and the equilibrium is that under perfect information. When search cost is intermediate, only the consumers with medium hassle costs do showrooming. A greater search cost curtails showrooming and relaxes competition, increasing both firms' profits. When search cost is high, showrooming does not arise. Consumers with relatively low hassle costs purchase directly from the online retailer, and the others make informed purchases from the traditional retailer. A higher search cost lowers the demand and profits of the traditional retailer and increases those of the online retailer. This result implies that the traditional retailer's efforts to reduce consumer search costs (e.g., relocating stores, free parking or improving other presale services) increase its profits for high search costs but may facilitate showrooming and hence hurt its profits otherwise. Second, showrooming lowers both firms' profits. We focus on markets where match uncertainty is low enough so that people are open to uninformed online purchases. The result that showrooming lowers the online retailer's profits depends on this assumption.[3] Contrary to common belief, showrooming hurts both retailers by facilitating price comparison and intensifying competition. An indirect evidence of this result is that traditional (e.g., Kohl's, Target, Walmart, and Macy's) and online retailers have been carrying more and more private and exclusive brands to curtail showrooming and price comparison in categories with modest and moderate match uncertainty (Tuttle 2012; Petro 2017). In these categories, consumers in general are willing to purchase directly online. For example, Amazon's well known private brand, AmazonBasics, covers simple furniture (such as bed frames, chairs, and shelving units), simple fitness equipment, shredders, luggage, comforters, cooking tools, and dinnerware among numerous other items. JD.com, China's leading online retailer, offers its own private brands in similar categories. Wayfair and AllModern, two major online retailers in home furnishings, also rely heavily on exclusive brands.

We then consider several important extensions. First, adding an online store expands the traditional retailer's demand but also intensifies competition, and, therefore, does not always increase its profits. When search cost is low, all consumers make informed purchases, and the competition effect dominates the demand-expansion effect, lowering the traditional retailer's profits. When search cost is intermediate, without an online presence, the traditional retailer only serves a fraction of the informed consumers. If match probability is small, its demand is limited and going online sufficiently expands its demand and increases its profits. Otherwise, expanding online lowers its profits. When search cost is sufficiently high, showrooming does not arise and few consumers purchase from the traditional retailer. Expanding online increases its profits by capturing some uninformed buyers.

Second, we examine the competitive implications of a product returns policy of the online retailer. The returns policy curtails showrooming, always (weakly) increases the traditional retailer's profits, but increases the online retailer's profits only for intermediate search costs. When search cost is low, all consumers make informed purchases and the returns policy does not alter the price equilibrium. When search cost is high, the online retailer only attracts uninformed buyers. The returns policy enables informed purchases and lowers its demand. For intermediate search costs, showrooming severely aggravates price rivalry as selling to uninformed buyers increases the online retailer's demand elasticity. The returns policy mitigates showrooming and relaxes competition, increasing both retailers' profits.

Third, the traditional retailer may battle showrooming through matching the price of the online competitor. Although a price-matching guarantee effectively eliminates showrooming, it may lower the prevailing price. Therefore, it increases the traditional retailer's profits for sufficiently high search costs but decreases its profits otherwise. When search cost is not high enough, the price-matching guarantee squeezes the online retailer's demand and hence price, which then decreases the traditional retailer's profits. When search cost is sufficiently high, price matching induces more consumers to patronize the traditional retailer and increases its profits.

Fourth, we relax the assumptions that consumers freely observe the traditional retailer's price and have an identical search cost. When the traditional retailer's price is ex ante not observable, both firms' prices and profits remain intact for low or medium search costs but are higher for high search costs. For low or medium search costs, some consumers will showroom. Once arriving at the traditional retailer, they learn its price. The decision scenario thus reduces to that of the basic model. When search cost is high, showrooming does not arise. That consumers decide where to buy without observing the traditional retailer's price relaxes competition. A counterintuitive implication is that the traditional retailer may not benefit from advertising price for high search costs. We separately consider the scenario where some consumers have a positive search cost and the others have zero search cost. Surprisingly, when the positive search cost is intermediate, both firms' prices increase in the population of consumers with zero search costs. In this case, more consumers with zero search cost reduce the amount of showrooming and weaken price rivalry.

Last, we incorporate webrooming into the model of showrooming. We first analyze the scenario where webrooming fully resolves consumers' match uncertainty. Without webrooming, a consumer must visit the traditional retailer to make an informed purchase. Those realizing a good match are then more likely to buy from the traditional retailer to avoid the additional hassle cost. By informing consumers about match, webrooming lowers the traditional retailer's demand and profits. Intriguingly, webrooming also lowers the online retailer's profits when search cost is high. Without webrooming, a high search cost induces many consumers to make uninformed online purchases. By enabling informed purchases, webrooming lowers the online retailer's demand and intensifies competition. Next, we consider the case where the product has digital and inspection attributes, so that webrooming only reveals match with the digital attribute. In this case, the consumers with a good match with the digital attribute are more willing to visit the traditional retailer to evaluate the inspection attribute. We show that webrooming may increase both firms' demand and profits by inducing greater participation.

In our stylized model, one traditional retailer competes with one online retailer in a product market where consumers are open to uninformed purchases. Our results and their managerial implications are interpreted in such a context. We note that showrooming also occurs in other contexts, and that the actual retail environment is often much more complex. In categories where consumers are reluctant to make uninformed purchases, showrooming may increase the online retailer's profits. In most categories, the consumer easily finds multiple nearby traditional retailers and multiple (or even many) online retailers. In such cases, competition among traditional retailers may prompt them to also sell online, and competition among online retailers easily forces them to accept product returns.

The paper is organized as follows. Section 2 reviews the related literature. Section 3 presents a basic model of showrooming and Section 4 its analysis. Section 5 conducts several extensions. We examine the profit effects of webrooming in Section 6. Section 7 concludes. An appendix and an online appendix provide the proofs and deductions, respectively.

2. Literature

Showrooming is a special kind of service free riding that is ubiquitous in the retail sector. Telser (1960) argues that free riding may lower retailers' incentive to provide presale services, and that resale price maintenance helps contain free riding, thus encouraging provision of such services. Because reduced retail service due to free riding jeopardizes product demand, Coughlan et al. (2001) and Carlton and Chevalier (2001) study manufacturers' various techniques to internalize this channel conflict. Singley and Williams (1995) further note that free riding may increase the price disparity between the service-providing and free-riding retailers.

Our model is closer to Wu et al. (2004) and Shin (2007). Wu et al. (2004) study free riding of information services in an oligopoly of multi-product *online* sellers, where some consumers have zero search costs and the others have an identical, positive search cost. The seller providing the information service captures the consumers with positive search cost and makes positive profits, while the free-riding online sellers compete for those with zero search costs and thus make zero profits. Shin (2007) examines service free riding between two brick-and-mortar retailers. Shin (2007) assumes that some consumers are ex ante informed and the others uninformed about product match, and that each uninformed consumer always first visits the service-providing retailer to discover match. Surprisingly, he shows that free riding may increase both firms' profits: If free riding is prohibited, the retailers would compete only for the informed consumers, which intensifies competition.

Our model complements these two models by examining free riding between *brick-and-mortar* and *online* retailers and incorporating the distinct characteristics of the two channels. We show that showrooming *decreases* both firms' profits, by contrast to Shin (2007). The reasons are as follows. First, in a purely online (Wu et al. 2004) or offline (Shin 2007) setting, it is reasonable to assume that each consumer faces the same cost to visit any seller, which intensifies price rivalry. In particular, if free riding were prohibited, competition would drive the profits of the retailer not providing service down to zero. In our setting, each consumer naturally faces different costs to patronize the online and traditional sellers. Because the consumers differ in their disutility of delayed consumption, the heterogeneity in hassle costs would ensure strictly positive profits for both sellers if showrooming were prohibited. Second, in Shin (2007) all uninformed consumers first visit the service-providing seller to discover match (i.e., consumers always make informed purchases). Those with low travel costs and a good match will then free ride. By contrast, we allow consumers to make uninformed purchases from the online seller. In our model, a consumer's hassle cost drives her shopping strategy. Those with high hassle costs buy from the traditional retailer, while the others make informed or uninformed purchases from the online retailer.

Our paper also relates to the literature on multichannel competition, price matching, and product returns. Loginova (2009) presents a model of many conventional and online stores and accounts for showrooming. All consumers must first visit the conventional stores to discover match, and the online stores lack differentiation and price at marginal cost. Balasubramanian (1998) examines competition between a direct marketer and conventional retailers (without showrooming). Buying from a conventional retailer requires a transportation cost, while buying from the direct marketer carries a fixed disutility, which reflects the lack of touch and feel, the cost and time of shipping, and the hassle of possible returns (Forman et al. 2009, Padmanabhan and Png 1997). Each conventional retailer serves the consumers nearby, and the direct marketer covers the rest of the market. Ofek et al. (2011), Zettelmeyer (2000), and Zhang (2009) examine retailers competing in online and offline channels, but do not address showrooming. In a duopoly, Ofek et al. (2011) and Zhang (2009) find that adding an online channel is not always optimal for traditional retailers. We reach a similar result in markets with showrooming. Kireyev et al. (2017) study a multichannel retailer matching its own online price in store under alternative market structures. They show that in a duopoly self-matching can dampen competition online and enable price discrimination in store. In a distribution channel with an endogenous manufacturer-retailer contract, Kuksov and Liao (2018) show that showrooming may increase the profits of the brick-and-mortar retailer.

The existing literature on price matching explains it as facilitating cartel pricing (e.g., Hay 1982) or price discrimination (e.g., Png and Hirshleifer 1987) or as a signal of a low-price image (e.g., Moorthy and Winter 2006). In cross-channel competition, we show that price matching by the traditional retailer effectively contains showrooming but may lower its profits by suppressing the prevailing price. Che (1996) studies how product returns affect welfare, and Hess et al. (1996) and Shulman et al. (2011) examine the use of restocking fees in managing returns. We show that a returns policy by the online retailer alleviates showrooming but does not always increase its profits.

Last, although the Internet generally lowers search costs (of discovering price) and intensifies price competition (e.g., Bakos 1997, Brynjolfsson and Smith 2000), there are exceptions. In Lal and Sarvary (1999), each consumer is already familiar (and largely satisfied) with one of the competing brands. By enabling each consumer to order her familiar brand online, the Internet discourages search and may lead to higher prices. When firms endogenize product positions, Kuksov (2004) shows that lower consumer search costs lead to greater product differentiation, which relaxes price rivalry. When match uncertainty is resolved via costly evaluation, Jing (2016) examines the firms' incentives to lower the evaluation costs of their products to influence customers' search sequence. In a two-period monopoly, Jing (2011) studies the interaction between seller-induced consumer learning and the firm's product release and pricing strategies. Iyer and Kuksov (2012) examine traditional retailers' competitive investment in shopping experience when consumers are uncertain about *prices* and face search costs to visit a retailer. In particular, when the value of the shopping experience is below search cost, improving shopping experience amounts to lowering search cost. By contrast, we consider search cost of discovering match and show that a greater search cost may increase or decrease the traditional retailer's profits.

3. A Model of Showrooming

We consider a duopoly of a traditional (brick-and-mortar) retailer, T, and a purely online retailer, E, both of which carry an identical product. Ex ante, consumers of unit mass are uncertain whether the product fits their idiosyncratic needs. Each consumer obtains utility r if it matches her need and zero utility otherwise. The product matches her need with probability λ and does not with probability $1-\lambda$.

A consumer can resolve her match uncertainty by visiting firm T at cost $s > 0$. Here s is the cost of traveling to the store. Once in the store, however, we assume that the additional effort for the consumer to gauge product match is negligible.[4] If the consumer discovers a poor match, she does not purchase. Otherwise, she may buy it from T or E. Buying from E requires a hassle cost h. Consumers are not equally skilled in navigating through the website, not equally comfortable with making payment online, and not equally patient when waiting for the order to arrive. Indeed, we observe that after ascertaining match in a physical store, some shoppers choose to buy from the store while others order online for a lower price. The former are often also aware of the price difference across channels: They purchase in store mainly because the price difference does not justify their hassle costs of buying online. For simplicity, we assume that h is uniformly distributed in $[0, 1]$. Alternatively, the consumer can also make an uninformed purchase from E (without visiting T) at hassle cost h. We assume that the consumer must incur travel cost s to buy from T. Since visiting T enables her to discover match, every purchase from T is an informed purchase. To ease analysis, we assume that

Table 1. Notation of the Basic Model

T	Index for the traditional retailer
E	Index for the online retailer
r	Product utility in case of a good match
λ	Probability of a good match
S	Travel (search) cost to the traditional retailer
p_i	Price of retailer i
u_T	Expected surplus of an informed purchase from T
u_E^U	Expected surplus of an uninformed purchase from E
u_E^S	Expected surplus of showrooming
π_i	Firm i's profits
π_i^{NS}	Firm i's profits without showrooming

all consumers face the same travel cost.[5] Without confusion, we also call s the consumers' search cost.

Let p_T and p_E denote the prices of firms T and E, respectively. Following convention (e.g., Telser 1960 and Shin 2007), we assume that both firms' prices are freely observable. This allows us to better focus on free riding of product information (i.e., showrooming) and facilitates benchmarking with the literature. Consumers easily find E's price on its website. Consumers can also easily locate T's price in the local newspaper, through a phone call or its website. An extension (Section 5.4) analyzes the scenario where ex ante p_T is not observable. For now, we assume that the traditional retailer does not sell online or match the price of its online competitor and that the online retailer does not allow product returns. We relax these assumptions in Sections 5.1–5.3. Table 1 summarizes the notation of the basic model.

The firms set prices simultaneously. Observing the prices, each consumer determines her shopping strategy. Firms and consumers are risk neutral and maximize their own expected payoffs. Consumer h faces three alternative shopping strategies: (1) Making an uninformed purchase from E yields expected surplus $u_E^U = \lambda r - p_E - h$; (2) Showrooming (i.e., visiting T first and buying from E in case of a good match) yields expected surplus $u_E^S = \lambda(r - p_E - h) - s$; (3) Making an informed purchase from T yields $u_T = \lambda(r - p_T) - s$. We assume that r is sufficiently high so that in equilibrium each of the three strategies yields non-negative surplus for all consumers. Our model thus focuses on product categories with limited match uncertainty (e.g., small appliances and consumer electronics, outdoor or simple furniture, casual apparel, toys, etc.), where consumers are willing to consider uninformed purchases (i.e., purchases without physical inspection). Throughout, we seek pure-strategy price equilibrium.

3.1. The Benchmark Without Showrooming

As a benchmark, we first consider the scenario without showrooming. Suppose that the products offered by T and E are independent and that ex ante each product has a match probability λ for a typical consumer. Because knowing the match with one product reveals no information about that with the other, showrooming does not arise. Each consumer can make an informed purchase from T or an uninformed purchase from E. Consumer h makes an informed purchase from T if $u_T > u_E^U \Leftrightarrow h > \lambda p_T - p_E + s$. The firms' profit functions are $\pi_T^{NS} = \lambda(1 - \lambda p_T + p_E - s)p_T$ and $\pi_E^{NS} = (\lambda p_T - p_E + s)p_E$. When $s < 2$, the unique price equilibrium is $p_T = (2 - s)/(3\lambda)$ and $p_E = (1 + s)/3$, and the firms make profits $\pi_T^{NS} = (2 - s)^2/9$ and $\pi_E^{NS} = (1 + s)^2/9$.

4. Analysis

The following three relations characterize consumer h's optimal shopping strategy:

$$u_E^S > u_E^U \;\Leftrightarrow\; h > \frac{s}{1-\lambda} - p_E, \tag{1}$$

$$u_E^S > u_T \;\Leftrightarrow\; h < p_T - p_E, \tag{2}$$

and

$$u_E^U > u_T \;\Leftrightarrow\; h < \lambda p_T - p_E + s. \tag{3}$$

Showrooming arises if and only if $s/(1-\lambda) - p_E < h < p_T - p_E$. When $h < p_T - p_E$, consumer h will purchase from E after visiting T and realizing a good match. Note that $s/(1-\lambda) - p_E < h \Leftrightarrow (1-\lambda)(p_E + h) > s$. When the expected gain from showrooming (relative to an uninformed purchase from E) $(1-\lambda)(p_E + h)$ exceeds its cost (s), consumer h will visit T. The following analysis has three cases.

Case (1): $p_E \geq s/(1-\lambda)$.

When $p_E \geq s/(1-\lambda)$, $u_E^S \geq u_E^U$, i.e., showrooming dominates uninformed purchases from E. Therefore, all consumers will visit T first. If the product is a good match, the consumers in $[p_T - p_E, 1]$ will purchase from T and those in $[0, p_T - p_E)$ will purchase from E. The firms' profit functions are $\pi_T = \lambda(1 - p_T + p_E)p_T$ and $\pi_E = \lambda(p_T - p_E)p_E$. The first-order conditions (FOCs) jointly lead to $p_T = \frac{2}{3}$ and $p_E = \frac{1}{3}$.

When $s \leq \lambda(1-\lambda)/(2+\lambda)$, $p_E \geq s/(1-\lambda)$ and we show that the above prices form an equilibrium. Clearly, E will not unilaterally deviate to any other price above $s/(1-\lambda)$, and T will not deviate to any other price above p_E. Suppose E deviates to $p_E' \leq s/(1-\lambda)$. Then, consumers in $[0, s/(1-\lambda) - p_E']$ make uninformed purchases from E, and the remaining consumers visit T. If realizing a good match, those in $[s/(1-\lambda) - p_E', p_T - p_E')$ buy from E and those in $[p_T - p_E', 1]$ buy from T, where $p_T = \frac{2}{3}$. Firm E's demand is $(s/(1-\lambda) - p_E') + \lambda(p_T - s/(1-\lambda)) = \lambda p_T - p_E' + s$, and its profit function is $\pi_E' = (\lambda p_T - p_E' + s)p_E'$. When $s \leq \lambda(1-\lambda)/(2+\lambda)$, E's optimal deviating price is $p_E' = s/(1-\lambda)$, with $\pi_E' = \lambda[2(1-\lambda) - 3s]s/(3(1-\lambda)^2)$. Such a deviation is not profitable for E since $\pi_E' \leq \lambda/9$ is equivalent to $[3s - (1-\lambda)]^2 \geq 0$, which always holds. Firm T's optimal deviating price at or below p_E is $p'_T = p_E = \frac{1}{3}$, yielding profits $\pi'_T = \lambda/3$. However, T will not deviate to such a price since $\lambda/3 \le 4\lambda/9$.

When search cost is sufficiently low ($s \le \lambda(1-\lambda)/(2+\lambda)$), all consumers make informed purchases. The equilibrium is that under perfect information. The consumers in $[0, \frac{1}{3}]$ will do showrooming, and the firms make profits $\pi_T = 4\lambda/9$ and $\pi_E = \lambda/9$.

Case (2): $p_T \ge s/(1-\lambda) \ge p_E$.

In this case, we have $p_T - p_E \ge \lambda p_T - p_E + s \ge s/(1-\lambda) - p_E \ge 0$. The consumers in $[0, s/(1-\lambda) - p_E)$ will make uninformed purchases from E, and the other consumers will visit T first. If realizing a good match, those in $[s/(1-\lambda) - p_E, p_T - p_E)$ will purchase from E and those in $[p_T - p_E, 1]$ will purchase from T. Since search cost s is also the cost of showrooming, as s rises, more consumers make uninformed purchases from E and fewer do showrooming. Firm T's profit function is $\pi_T = \lambda(1 - p_T + p_E)p_T$. Firm E's demand is $(s/(1-\lambda) - p_E) + \lambda[(p_T - p_E) - (s/(1-\lambda) - p_E)] = \lambda p_T - p_E + s$. Its profit function is thus $\pi_E = (\lambda p_T - p_E + s)p_E$. The FOCs jointly lead to $p_T = (2+s)/(4-\lambda)$ and $p_E = (\lambda + 2s)/(4-\lambda)$.

When $(1-\lambda)/3 \le s \le 2(1-\lambda)/3$, we can verify that these prices are an equilibrium (see Online Appendix TA1). As s rises, p_E increases faster than p_T. The reason is that a greater search cost increases the demand of the online retailer, but does not directly affect that of the traditional retailer. The firms make profits $\pi_T = \lambda(2+s)/(4-\lambda))^2$ and $\pi_E = ((\lambda+2s)/(4-\lambda))^2$. In this case, search cost is not trivial so that the consumers with low hassle costs (in $[0, s/(1-\lambda) - (\lambda+2s)/(4-\lambda)]$) would rather make uninformed purchases from E. Meanwhile, search cost is also not too high and the consumers with medium hassle costs (in $[s/(1-\lambda) - (\lambda+2s)/(4-\lambda), (2-\lambda-s)/(4-\lambda)]$) will do showrooming. For instance, when $\lambda = 1/4$ and $s = (1-\lambda)/3$, consumers in $[2/15, 2/5]$ showroom. When $\lambda = 1/2$ and $s = (1-\lambda)/3$, consumers in $[2/21, 8/21]$ showroom.

Case (3): $p_T \le s/(1-\lambda)$.

When $p_T \le s/(1-\lambda)$, we have $p_T - p_E \le \lambda p_T - p_E + s \le s/(1-\lambda) - p_E$. In this case, search cost is so high that showrooming does not arise. The consumers in $[\lambda p_T - p_E + s, 1]$ make informed purchases from T, and those in $[0, \lambda p_T - p_E + s)$ make uninformed purchases from E. Firm T's profit function is $\pi_T = \lambda(1 - \lambda p_T + p_E - s)p_T$, and that of firm E is $\pi_E = (\lambda p_T - p_E + s)p_E$. The FOCs yield $p_T = (2-s)/(3\lambda)$ and $p_E = (1+s)/3$. When $2(1-\lambda)/(1+2\lambda) < s < 2$, these prices are an equilibrium (see Online Appendix TA2). In equilibrium, consumers in $[0, (1+s)/3]$ make uninformed purchases from E and those in $((1+s)/3, 1]$ make informed purchases from T. The firms make profits $\pi_T = (2-s)^2/9$ and $\pi_E = (1+s)^2/9$. Because a greater search cost expands E's and squeezes T's demand, p_E increases and p_T decreases in s. Proposition 1 summarizes the above analysis.

Proposition 1. *Case* (1). *For low search costs* $(s \le \lambda(1-\lambda)/(2+\lambda))$, *the unique equilibrium is* $p_T = 2/3$ *and* $p_E = 1/3$. *Both firms' prices and profits are independent of search cost. Consumers in* $[0, 1/3]$ *do showrooming. Case* (2). *For intermediate search costs* $((1-\lambda)/3 \le s \le 2(1-\lambda)/3)$, *the unique equilibrium is* $p_T = (2+s)/(4-\lambda)$ *and* $p_E = (\lambda+2s)/(4-\lambda)$. *Both firms' prices and profits increase in search cost. Consumers in* $[s/(1-\lambda) - (\lambda+2s)/(4-\lambda), (2-\lambda-s)/(4-\lambda)]$ *do showrooming. Case* (3). *For high search costs* $(2(1-\lambda)/(1+2\lambda) < s < 2)$, *the unique equilibrium is* $p_T = (2-s)/(3\lambda)$ *and* $p_E = (1+s)/3$. *Firm T's price and profits decrease and those of E increase in search cost. Showrooming does not arise in this case.*[6]

The three cases feature distinct market segmentation (see Figure 1) and comparative statics. Because a greater search cost makes T less attractive to consumers, firm E's price and profits (weakly) increase in search cost in each case. However, it is somewhat surprising that firm T's price and profits also increase in s in Case (2). The reason is that search cost is the cost of buying from T and the cost of showrooming. For inter-

Figure 1. (Color online) Equilibrium Market Segmentation

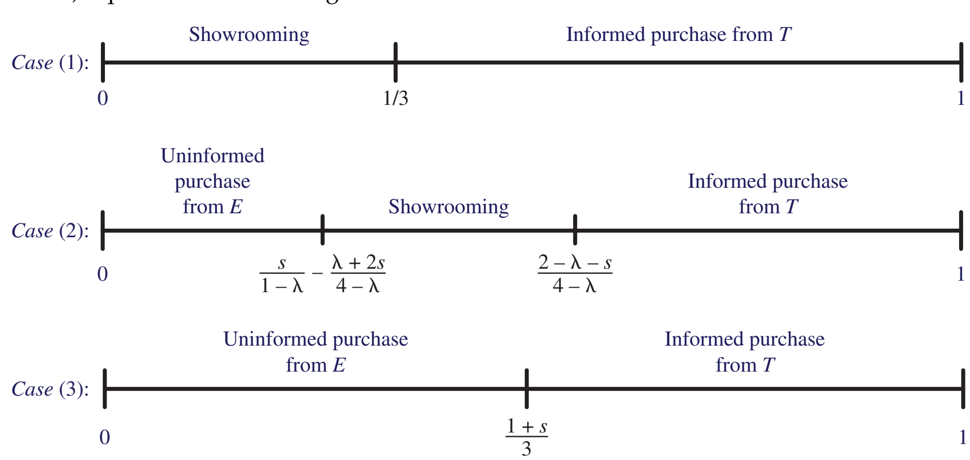
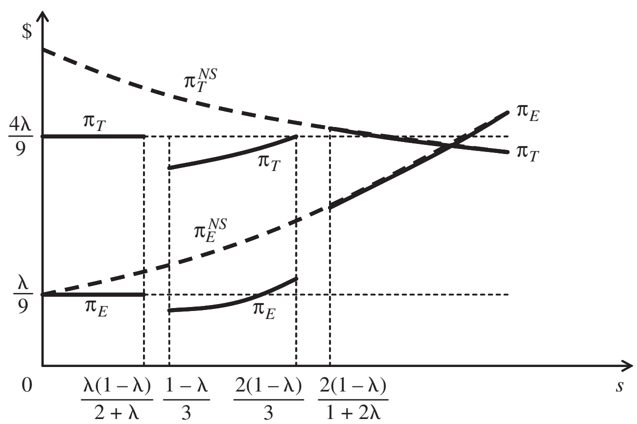


Figure 2. Firm Profits as Functions of Search Cost



mediate search costs (Case (2)), the consumers with low hassle costs ($[0, s/(1-\lambda) - p_E]$) make uninformed purchases from E, those with medium hassle costs ($(s/(1-\lambda) - p_E, p_T - p_E]$) do showrooming, and those with high hassle costs ($(p_T - p_E, 1]$) make informed purchases from T. *As search cost rises in this range, more consumers make uninformed purchases from E and fewer do showrooming, thus increasing E's demand without directly affecting T's*. Therefore, a greater search cost weakens price rivalry and increases both firms' prices.

Note how each firm's price and profits vary with search cost across the three cases (see Figure 2). In Case (1), search cost is low so that all consumers visit T to make informed purchases (from either firm). The equilibrium reduces to that under perfect information. In Case (2), T's demand function remains the same as in Case (1). However, because the consumers with low hassle costs make uninformed purchases from E, E's demand elasticity increases (from $|\partial D_E/\partial p_E| = \lambda$ to 1). This intensifies competition and each firm's price and profits are lower than in Case (1). In Case (3), search cost is high so that no consumer conducts showrooming. Firm E' s demand function is the same as in Case (2), but T's demand elasticity decreases (from $|\partial D_T/\partial p_T| = \lambda$ to λ^2), which weakens price rivalry. However, T's demand decreases and E's increases in search cost. Therefore, E's price and profits are strictly higher and T's may be higher (when search cost is not too high) or lower (when search cost is very high) than in Cases (1) and (2).

A key driver of our model is the dual role of search cost: It is the cost of buying from the traditional retailer and the cost of showrooming. Lowering search cost thus has mixed effects: A lower search cost induces more consumers to visit T but also facilitates showrooming, which intensifies competition. Therefore, the traditional retailer need not always benefit from a lower search cost. Proposition 1 points out the market conditions where the traditional retailer may benefit or suffer from lowering search cost.

In practice, many traditional retailers have boosted their efforts to attract shoppers through lowering search costs (e.g., relocating stores or opening new stores closer to residential areas, issuing parking coupons). Some retailers such as Best Buy, Target, and IKEA also enhance their presale services and shopping ambience (Zimmerman 2012; Olenski 2013). Because every visiting consumer enjoys such benefits regardless of purchase, enhancing presale services and shopping ambience amounts to lowering search cost (Iyer and Kuksov 2012). In markets with showrooming, Proposition 1 implies that the traditional retailer benefits most from such efforts when search cost is sufficiently high (Case (3)). For intermediate search costs, however, modest reduction of search cost may even lower its profits by facilitating showrooming.[7] It benefits only if search cost is significantly reduced to fall from Case (2) to Case (1).

Note also how equilibrium prices vary with match probability (λ). In Case (1), all consumers make informed purchases and the prices are thus independent of λ. In Case (2), both firms' prices increase in λ, because a greater match probability reduces the amount of showrooming ($p_T - s/(1-\lambda)$) and relaxes competition. In Case (3), the traditional retailer's price decreases in λ, because a greater match probability reduces the appeal of an informed purchase and lowers the traditional retailer's demand. The online retailer attracts only uninformed buyers and its price is independent of λ.

Proposition 2. *Showrooming (weakly) decreases both firms' profits.*

Proposition 2 follows from comparing each firm's profits with and without showrooming. When some of the consumers visiting T turn to buy from E, showrooming naturally (weakly) lowers T's profits. Interestingly, our model describes a setting where showrooming also lowers E's profits. In the absence of showrooming (Section 3.1), consumers face two options, i.e., (1) making an uninformed purchase from E and (2) making an informed purchase from T. Showrooming enables a new option of making an informed purchase from E, which intensifies price rivalry. Formally, without showrooming firm T's demand elasticity is $|\partial D_T^{NS}/\partial p_T| = \lambda^2$. In Cases (1) and (2), showrooming increases T's demand elasticity to λ, thus lowering its price. This then forces E to lower its price. In Case (3), showrooming does not arise and hence the equilibrium remains intact.

The popular press often depicts traditional retailers as the victims and online retailers as the winners of showrooming (Zimmerman 2012). Our result that showrooming lowers the online retailer's profits seems to counter such an impression. The reasons are as follows. First, our model examines categories where match uncertainty is not too high so that consumers are willing to consider uninformed online purchases (e.g., small appliances and consumer electronics, casual apparel, outdoor or simple furniture, toys, kitchenware, etc.), although this need not be their optimal shopping strategy. It is in such a setting that showrooming intensifies price competition and lowers both retailers' profits.[8] Second, in our model, ex ante the consumer already knows her product of interest (through, for example, advertisement, word of mouth or seeing others use it) subject to some match uncertainty. She may then look up its prices online before deciding whether to visit the physical retailer to resolve her match uncertainty.[9] Although the type of showrooming we consider is very common, in reality there still exist other types of showrooming. Therefore, Proposition 2 represents only one of the possibilities.

There are two alternative types of showrooming. In one scenario, ex ante the consumer may only detect a need in some category (e.g., a pair of shoes) but does not know exactly which product (brand, model, and size) she wants. Before identifying her product of interest, very likely she would not bother to discover and remember the online retailer's prices of all varieties in the category. Once she visits the traditional retailer, she identifies her product of interest and its price. She may then wish to check the online retailer's price to decide where to buy. This is when a price-comparison mobile app by the online retailer (such as Amazon) makes a difference. If she easily discovers the online retailer's price and if it is sufficiently lower than the traditional retailer's, she may order from the online retailer instead. Another scenario involves impulse purchases. While in the physical store, the consumer may find some interesting but unplanned product. In this case, she also wishes to access the online retailer's price to decide where to buy, and a price-comparison app may work to the advantage of the online retailer.

In recent years, to counter showrooming, traditional (e.g., Macy's, Nordstrom, and Target) and online retailers began carrying more varieties of exclusive products that cannot be found elsewhere (Tuttle 2012). Kohl's private brands now account for about 50% of its total sales (Petro 2017). Amazon has also developed private brands in many categories. In categories with modest and moderate match uncertainty, Amazon's private brand, AmazonBasics, covers simple furniture (e.g., bed frames, chairs, and shelving units), simple fitness equipment, luggage, shredders, comforter, cooking tools, and dinnerware among many others. JD.com, a leading online retailer in China, has developed its own private brands in similar categories. Wayfair and AllModern, two leading retailers in home furnishings, also rely heavily on private and exclusive brands.

Proposition 2 contrasts with Shin (2007), who shows that service free riding between two conventional sellers may help increase both firms' profits. The reason for the contrast is as follows. In Shin (2007), each consumer faces the same cost to visit either seller, and the uninformed consumers always make informed purchases by first visiting the service-providing seller. When free riding is prohibited, competition for the ex ante informed consumers drives the price of the seller not providing service down to marginal cost. In this setting, service free riding relaxes price rivalry. In our model, each consumer naturally faces different costs to patronize the online and traditional sellers, and is allowed to make uninformed purchases from the online seller (consistent with observations in many categories). When showrooming is prohibited, the heterogeneous hassle costs of online buying then ensure strictly positive profits for both sellers. As noted above, showrooming tightens price competition.

5. Extensions

5.1. Adding an Online Channel by the Traditional Retailer

Today, many traditional retailers (e.g., Walmart, Macy's, Target) also sell online. In our model, adding an online channel may help the traditional retailer capture some online buyers (the *demand-expansion* effect), but intensifies competition and hurts its offline business (the *competition* effect). When does the traditional retailer benefit from adding an online channel? How does showrooming affect competition between the multichannel retailer and the pure-play online retailer? We examine these questions next.

Besides selling through its physical store at price p_T, suppose the traditional retailer also sells online at price p_O. For simplicity, we ignore any fixed costs of setting up the online store.[10] We suppose that the traditional retailer offers a less smooth online shopping experience compared with its online rival. Specifically, a consumer $h \in [0, 1]$ incurs a higher hassle cost θh (where $\theta > 1$) when buying from the online store of the traditional retailer. This assumption is plausible since the websites of many traditional retailers are not as user friendly or do not offer as detailed information or personalization as the leading online retailers. For instance, Walmart's online operations still markedly lag behind Amazon.com, despite the billions of dollars invested by Walmart in recent years (Wahba 2016). This implies that $p_O < p_E$ must hold for the traditional retailer to attract online buyers. Each consumer now faces two more shopping alternatives: Making an uninformed and informed purchase from the traditional retailer's online store yields expected surplus $\lambda r - p_O - \theta h$ and $\lambda(r - p_O - \theta h) - s$, respectively.

The properties of the price equilibrium (see Proposition A.1 in the appendix) resemble those of Proposition 1. For low search costs, all consumers visit T's physical store first. If realizing a good match, the consumers with relatively low hassle costs purchase online from T

and E, and the others from T's physical store. The equilibrium is the one under perfect information. For intermediate search costs, the firms' prices all increase in search cost. The consumers with low hassle costs make uninformed online purchases from T and E, those with medium hassle costs do showrooming, and the others make informed purchases from T's physical store. For high search costs, T's offline price decreases but both firms' online prices increase in search cost. Showrooming does not arise. Consumers make uninformed online purchases from T and E, or make informed purchases from T's physical store. We can easily verify that showrooming intensifies competition and (weakly) lowers both firms' profits.

Proposition 3. Case (1). *When search cost is low* $(0 < s \le \min\{\lambda(1-\lambda)/(2+\lambda), (1-\lambda)(\theta-1)/(6\theta)\})$, *adding the online channel lowers firm T's profits.* Case (2). *When search cost is intermediate* $(\max\{(1-\lambda)/3, (1-\lambda)(2\theta-1)/(2\theta(2+\lambda))\} \le s \le (1-\lambda)(4\theta-1)/(6\theta))$, *adding the online channel increases firm T's profits when λ is sufficiently small and decreases T's profits when λ is sufficiently large.* Case (3). *When search cost is high* $(2(1-\lambda)/(1+2\lambda) \le s \le (4\theta-1)/(2\theta+1))$, *adding the online channel increases T's profits when* $s > (7\theta-2)/(5\theta+2)$ *and lowers its profits otherwise.*

Proposition 3 shows that expanding online does not always help the traditional retailer in the battle of showrooming. This echoes the finding of Ofek et al. (2011) and Zhang (2009) that adding an online channel may decrease a traditional retailer's profits. When search cost is low, all consumers make informed purchases. The competition effect of adding an online channel dominates its demand-expansion effect, lowering T's profits. When search cost is intermediate, without an online presence T only sells to some of the consumers who visit its physical store and discover a good match. When match probability is low, T's demand is limited and the demand-expansion effect of going online dominates, increasing T's profits. When match probability is large, T's demand is sufficiently high, and the competition effect is more salient and lowers its profits. When search cost is high, showrooming does not arise. As search cost rises, fewer consumers will visit T to make informed purchases. When search cost is sufficiently high ($s > (7\theta-2)/(5\theta+2)$), adding an online channel allows T to capture some of the uninformed buyers and increases its profits.

Today, virtually every major traditional retailer sells online, while Proposition 3 predicts that going online increases the traditional retailer's profits only under certain conditions. The reason for this discrepancy includes at least the following. First, Proposition 3 is obtained in a context of showrooming, but in practice, most retailers also carry exclusive products and standard, convenience, and packaged goods, which are not common objects of showrooming. Second, operating an online store often serves the strategic purposes of customer engagement and better understanding consumer behavior. Third, our stylized model above does not incorporate the potential synergies between a retailer's online and offline operations (e.g., using stores to fulfill online orders, allowing consumers to return online purchases to a local store, directing traffic to the store by offering discounts for ordering online and picking up in store).

5.2. A Returns Policy by the Online Retailer

In our basic model, showrooming is the only means of making an informed purchase from the online retailer. Because the online retailer may enable informed purchases by allowing product returns, one wonders when it benefits from a returns policy. For simplicity, we assume that the consumer may return a product with a poor match for a full refund at no extra cost to herself (as in Davis et al. 1995 and Che 1996), and that the online retailer incurs a cost d ($d \ge 0$) to process each returned order (as in Ofek et al. 2011). Each consumer has three shopping strategies. Ordering directly from E and returning the product in case of a mismatch yield expected surplus $u_E^R = \lambda(r - p_E) - h$. Showrooming yields expected surplus $u_E^S = \lambda(r - p_E - h) - s$. An informed purchase from T yields expected surplus $u_T = \lambda(r - p_T) - s$. We can easily verify that

$$u_E^R > u_E^S \iff h < \frac{s}{1-\lambda}, \tag{4}$$

$$u_E^R > u_T \iff h < s + \lambda(p_T - p_E), \tag{5}$$

and

$$u_E^S > u_T \iff h < p_T - p_E. \tag{6}$$

Consumer h does showrooming if and only if $s/(1-\lambda) < h < p_T - p_E$. Recall, consumers in $[s/(1-\lambda) - p_E, p_T - p_E]$ showroom in the basic model. The returns policy by E curtails showrooming.

The unique price equilibrium is given in Proposition A.2 (in the appendix). Proposition 4 follows directly from comparing the firms' profits with and without E's returns policy.

Proposition 4. *Suppose the online retailer E offers a returns policy.* Case (1). *For low search costs* $(s \le \min\{\lambda(1-\lambda)/(2+\lambda), ((1-\lambda)[2\lambda - 3(1-\lambda)d])/(3(1+\lambda))\})$, *the returns policy lowers E's profits and does not affect T's.* Case (2). *For intermediate search costs* $((1-\lambda)[2+(1-\lambda)d]/(1+5\lambda) < s < 2(1-\lambda)/3)$, *the returns policy increases E's profits if* $d < (4(1-\lambda) - (2+\lambda)s)/((1-\lambda)(4-\lambda))$ *and decreases its profits otherwise. The returns policy increases T's profits.* Case (3). *For high search costs* $(\max\{2(1-\lambda)/(1+2\lambda), (1-\lambda)[2+(1-\lambda)d]/(1+5\lambda)\} < s < 2)$, *the returns policy decreases E's profits and increases T's profits.*

The returns policy does not always increase the online retailer's profits. When search cost is low (as in Case (1)), all consumers make informed purchases even without a returns policy. The returns policy does not increase E's demand but merely raises its costs. When search cost is high (Case (3)), without the returns policy showrooming does not arise and E only attracts uninformed buyers. The returns policy enables informed purchases from E and reduces its demand. This together with a higher cost lowers its profits. For intermediate search costs (Case (2)), showrooming aggravates competition most severely (see Figure 2), as selling to some uninformed buyers increases E's demand elasticity. In this case, the returns policy reduces the amount of showrooming and weakens competition, increasing E's profits provided the cost of return is sufficiently low. Interestingly, E's returns policy (weakly) increases the traditional retailer's profits. For low search costs, the perfect-information equilibrium remains intact. For intermediate search costs, E's returns policy curtails showrooming and weakens competition. For high search costs, the returns policy lowers E's demand elasticity and raises its (marginal) cost, relaxing price rivalry and increasing T's profits.

Proposition 4 shows that the online retailer benefits from a returns policy only for intermediate search costs. This does not seem to fully explain the prevalence of returns policies among online retailers. The reasons are as follows. First, our model considers one traditional and one online retailer. In reality, however, there are multiple online retailers in virtually every category, where allowing returns easily becomes an equilibrium choice: When the other online retailers allow returns, the one that does not would have a significant disadvantage. Second, our model concerns a setting with limited match uncertainty, where the consumer is willing to consider uninformed purchase (although this may not be her best option). In categories where match uncertainty is highly severe and people are reluctant to make uninformed purchases, a returns policy easily increases the online retailer's demand and profits under broader market conditions. For example, Warby Parker allows a consumer to order five pairs of eyeglasses and Amazon allows each Prime member to order up to 15 fashion items (under its Prime Wardrobe program) to try on at home. In both cases, the consumer may return any unwanted items at no charge.

5.3. Price Matching by the Traditional Retailer

Many traditional retailers also offer price matching guarantees to battle showrooming. The intuition seems very simple: If the consumers visiting the traditional retailer realize a good match, offering them the online rival's price would induce them to buy from the former, as buying from the latter entails an additional hassle cost. We now examine the effects of such a price-matching guarantee in the basic model. For simplicity, we assume that all consumers are aware of the guarantee and incur no cost to invoke it. Provided $p_T \geq p_E$, the expected surplus of buying from T becomes $u_T = \lambda(r - p_E) - s$. Making an uninformed purchase from E yields expected surplus $u_E^U = \lambda r - p_E - h$, and showrooming yields $u_E^S = \lambda(r - p_E - h) - s$. Since $u_T \geq u_E^S$ for all $h \geq 0$, price matching eliminates showrooming. Then $u_E^U \geq u_T$ is equivalent to $h \leq s - (1-\lambda)p_E$, i.e., the consumers in $[0, s - (1-\lambda)p_E]$ will make uninformed purchases from E and the remaining consumers will make informed purchases from T. The firms' profit functions are $\pi_T = \lambda[1 - s + (1-\lambda)p_E]p_E$ and $\pi_E = [s - (1-\lambda)p_E]p_E$, respectively. The equilibrium price is $p_E = s/(2(1-\lambda))$. The firms make profits $\pi_E = s^2/(4(1-\lambda))$ and $\pi_T = \lambda(2-s)s/(4(1-\lambda))$. Proposition 5 then follows from comparing T's profits with and without price matching.

Proposition 5. *In Cases* (1) *and* (2) *of Proposition* 1, *offering the price-matching guarantee decreases firm T's profits. In Case* (3), *the price-matching guarantee increases T's profits when* $8(1-\lambda)/(4+5\lambda) < s \leq 2$, *and decreases T's profits otherwise.*

Interestingly, firm T does not always benefit from the price-matching guarantee, even though it may expand T's demand by eliminating showrooming. For low and intermediate search costs (Cases (1) and (2) of Proposition 1), the price matching guarantee decreases T's profits by forcing firm E to price too aggressively. Search cost limits E's demand $(s - (1-\lambda)p_E)$ and hence its price p_E. Since each customer of T also pays p_E, this decreases T's profits when search cost is not sufficiently high.

For high search costs (Case (3)), without price matching consumers make uninformed purchases from E or informed purchases from T. The high search cost limits T's demand and profits. When search cost is sufficiently high ($s > 8(1-\lambda)/(4+5\lambda)$), price matching helps attract more consumers to patronize T and increases its profits.

Our model assumes that one traditional retailer competes with one online retailer, and that all consumers are aware of the price-matching policy. In practice, each traditional retailer often competes with several local and online retailers, and only a small percentage of consumers are conscious of and take advantage of a vendor's price matching guarantee. In recent years, most major traditional retailers have attempted to match (online and offline) competitors' prices, with mixed results. Although price matching is believed to have helped Best Buy to survive, its effects are less potent for Toys "R" Us and Walmart (Roose 2017). After stopping price matching in 800 stores in 2016, Walmart recently further shut down price matching in its Minnesota stores (Ewoldt 2017).

5.4. The Traditional Retailer's Price Is Ex Ante Not Observable

Following convention in the free-riding literature, our basic model assumes that both firms' prices are ex ante freely observable. We now consider the scenario where the online retailer's price (p_E) is freely observable but the traditional retailer's price (p_T) has to be discovered (together with product match) through a store visit. We retain the remaining setup of the basic model. Because the consumers observe the search cost and the online retailer's price, they can infer the price of the traditional retailer. We seek a fulfilled-expectations equilibrium in pure strategies, where consumers' expected price of the traditional retailer equals its true price.

Proposition 6. *Suppose firm T's price p_T is ex ante not observable. Case* (1). *When search cost is low* ($s \le (\lambda(1-\lambda))/(2+\lambda)$), *the unique equilibrium is $p_E = 1/3$ and $p_T = 2/3$. Case* (2). *When search cost is intermediate* ($(1-\lambda)/3 \le s \le (2(1-\lambda))/3$), *the unique equilibrium is $p_E = (2+s)/(4-\lambda)$ and $p_T = (\lambda+2s)/(4-\lambda)$. Case* (3). *When search cost is high* ($s > (2(1-\lambda))/3$), *the unique equilibrium is $p_E = s/(2(1-\lambda))$ and $p_T = s/(1-\lambda)$.*

The proof is given in Online Appendix TA3. The equilibrium in Cases (1) and (2) is identical to that in the basic model. When search cost is low or intermediate, some or all consumers will visit T to discover match (whether T's price is ex ante observable). Once arriving at T, however, they also learn T's price. The decision scenario thus degenerates to that of the basic model. When search cost is high (Case (3)), showrooming does not arise and consumers must decide where to buy without observing T's price, which relaxes competition. Each firm's price increases in search cost and is higher than when T's price is observable. Interestingly, this implies that T may not benefit from advertising its price when search cost is high.

5.5. Consumers Have Heterogeneous Search Costs

In the basic model, consumers have the same search cost. We now examine the scenario with heterogeneous search costs. For simplicity, we suppose α $(0 < \alpha < 1)$ consumers have search cost $s > 0$ and the remaining $1-\alpha$ consumers have zero search cost, as in Stahl (1989) and Lal and Matutes (1994). As noted by Lal and Matutes (1994) and Iyer and Kuksov (2012), in many markets some consumers enjoy shopping and have negligible search costs. For simplicity, we call the consumers with zero search cost "shoppers" and the others "searchers." We assume that a consumer's search cost is independent of her hassle cost of buying online, which is still uniformly distributed in $[0,1]$. Clearly, the shoppers will always make informed purchases. Proposition 7 follows from Proposition A.3 in the appendix.

Proposition 7. *When $(1-\lambda)/3 < s \le 2(1-\lambda)/3$, both firms' prices increase in the population of shoppers (i.e., $1-\alpha$).*

Our intuition says that a greater shopper population would intensify competition. Surprisingly, *in the presence of showrooming a greater shopper population relaxes price rivalry when* $(1-\lambda)/3 < s \le 2(1-\lambda)/3$. The reason is that a higher shopper population $(1-\alpha)$ reduces the amount of showrooming and lowers firm E's demand elasticity. Note that the searchers' decision rule is as in Case (2) of the basic model. In case of a good match, the shoppers in $[0, p_T - p_E]$ purchase from E and the remaining shoppers purchase from T. We can verify that the demand of E is now $D_E = \lambda p_T - [\lambda + (1-\lambda)\alpha]p_E + \alpha s$. The demand of T is still $\lambda(p_T - p_E)$. Clearly, a greater population of shoppers decreases firm E's demand elasticity and weakens competition.

6. Webrooming

Showrooming is not the only information externality between the traditional and online sellers. Webrooming arises when consumers ultimately buy from the traditional retailer after accessing product information provided by the online retailer. Next, we incorporate webrooming into the basic model and analyze its profit effects. We separately consider two cases.

6.1. Webrooming Fully Resolves Match Uncertainty

In certain categories (e.g., digital accessories and small appliances), the relevant information for evaluating match can be fully digitized. When firm E posts such information online, all consumers costlessly discover their product match. A consumer with a good match will purchase from E if $p_E + h < p_T + s \Leftrightarrow h < p_T - p_E + s$, and will purchase from T otherwise. Firms T and E's profit functions are $\pi_T = \lambda(1 - p_T + p_E - s)p_T$ and $\pi_E = \lambda(p_T - p_E + s)p_E$, respectively. When $0 < s < 2$, we can verify that $p_T = (2-s)/3$ and $p_E = (1+s)/3$ are the unique equilibrium. The firms make profits $\pi_T^W = \lambda(2-s)^2/9$ and $\pi_E^W = \lambda(1+s)^2/9$. Proposition 8 follows from comparing π_T^W and π_E^W with the firms' profits in the basic model.

Proposition 8. *Case* (1). *For low search costs* ($0 < s \le \lambda(1-\lambda)/(2+\lambda)$), *webrooming decreases T's and increases E's profits. Case* (2). *For intermediate search costs* ($(1-\lambda)/3 < s \le 2(1-\lambda)/3$), *webrooming decreases E's profits if λ is small and increases E's profits if λ is sufficiently large. Webrooming decreases T's profits. Case* (3). *For high search costs* ($2(1-\lambda)/(1+2\lambda) < s < 2$), *webrooming decreases both firms' profits.*

As expected, webrooming always decreases firm T's profits. Without webrooming, a consumer must visit T for an informed purchase from either firm. Once discovering a good match, however, the consumer is more likely to buy from T as buying from E requires an additional hassle cost. By informing consumers about match, webrooming eliminates this advantage of T and lowers its demand.

Interestingly, *firm E need not benefit from webrooming*. When search cost is low (Case (1)), all consumers make informed purchases and the industry demand equals λ even without webrooming. Webrooming increases E's demand (from $\lambda(p_T - p_E)$ to $\lambda(p_T - p_E + s)$) and hence its profits. When search cost is high (Case (3)), without webrooming a consumer makes an uninformed purchase from E or an informed purchase from T. The high search cost limits the demand of T and raises that of E. In this case, webrooming facilitates informed purchases from E and lowers its demand. This intensifies price rivalry and hurts E's profits.

6.2. Webrooming Partially Resolves Match Uncertainty

When the product comprises a digital attribute (an attribute whose match value can be conveyed digitally; see Lal and Sarvary 1999) and an inspection attribute, webrooming only resolves partial match uncertainty. One example is clothes. While style can be conveyed graphically online, assessing fit still requires physical inspection. Suppose that the digital (inspection) attribute matches a consumer's taste with probability λ_d (λ_i), and that the match of one attribute is independent of that of the other. The product has utility r for the consumer if both attributes match her tastes and zero utility otherwise. Consumers differ in their search costs of visiting T. A population α have a positive search cost s, and the remaining $1-\alpha$ zero search cost. Their hassle costs of online buying (h) are independent of search costs and are uniformly distributed in $[0,1]$.

We first consider the case without webrooming (where E does not provide information about the digital attribute) as a benchmark. Suppose λ_d is sufficiently low so that only the consumers with zero search costs will visit T (the precise condition will be identified shortly). After visiting T, with probability $\lambda_d\lambda_i$ a consumer realizes a good match with both attributes. Among these, consumers with $h > p_T - p_E$ buy from T and consumers with $h \le p_T - p_E$ buy from E. The firms' profit functions are $\pi_T^{NW} = (1-\alpha)\cdot \lambda_d\lambda_i(1-p_T+p_E)p_T$ and $\pi_E^{NW} = (1-\alpha)\lambda_d\lambda_i(p_T-p_E)p_E$. The FOCs lead to $p_T = \frac{2}{3}$ and $p_E = \frac{1}{3}$. When $\lambda_d\lambda_i r - p_E \le 0$ ($\Leftrightarrow \lambda_d\lambda_i \le 1/(3r)$), no consumer makes uninformed purchase from E. When $\lambda_d\lambda_i(r-p_E) - s \le 0$ ($\Leftrightarrow \lambda_d\lambda_i \le 3s/(3r-1)$), no consumer with search cost s does showrooming. Under these two conditions, we have $\lambda_d\lambda_i(r-p_T) - s < 0$ (since $p_T > p_E$), i.e., no consumer with search cost s purchases from T. Therefore, when $\lambda_d\lambda_i \le \min\{1/(3r), 3s/(3r-1)\}$, only the consumers with zero search cost visit T, and the unique equilibrium is $p_T = \frac{2}{3}$ and $p_E = \frac{1}{3}$. The firms make profits $\pi_T^{NW} = (4(1-\alpha)\lambda_d\lambda_i)/9$ and $\pi_E^{NW} = ((1-\alpha)\lambda_d\lambda_i)/9$.

We now consider webrooming. Suppose that firm E provides relevant information online so that each consumer freely discovers her match with the digital attribute. When all consumers with a good match with the digital attribute visit T, the firms' profit functions are $\pi_T^W = \lambda_d\lambda_i(1-p_T+p_E)p_T$ and $\pi_E^W = \lambda_d\lambda_i(p_T-p_E)p_E$. When $\lambda_i(r-\frac{2}{3}) > s$, all consumers with a good match with the digital attribute will visit T, and the equilibrium prices remain $p_T = \frac{2}{3}$ and $p_E = \frac{1}{3}$. Webrooming induces more consumers to participate and increases both firms' profits to $\pi_T^W = 4\lambda_d\lambda_i/9$ and $\pi_E^W = \lambda_d\lambda_i/9$.

7. Conclusion

Our model focuses on product categories with limited match uncertainty (e.g., small appliances and consumer electronics, outdoor or simple furniture, casual dress, toys), where consumers are willing to consider uninformed online purchases (although this may not be their optimal shopping strategy). In these markets, our central insight is that showrooming intensifies price competition, which underlies several counterintuitive results: (1) As search cost rises in an intermediate range, it mitigates showrooming and relaxes competition, increasing the traditional retailer's profits. This implies that the traditional retailer's effort to lower search cost may inadvertently aggravate showrooming and decrease its profits. (2) Showrooming lowers both retailers' profits (relative to the case with independent goods). This supports traditional and online retailers' recent attempts to carry more varieties of exclusive products. (3) The returns policy of the online retailer curtails showrooming and relaxes competition, which may increase both firms' profits. (4) When some consumers have a positive search cost and the others have zero search cost, a greater population of consumers with zero search cost may mitigate showrooming and relax price rivalry. (5) When webrooming fully reveals match, it eliminates showrooming and may relax competition and increase the online retailer's profits.

Two features of our model deserve further discussion. First, our model has examined product categories where match uncertainty is not exorbitant so that consumers are willing to consider uninformed purchases. In categories where match uncertainty is so severe that consumers are hesitant to make uninformed purchases (e.g., cars and certain other big-ticket durables), showrooming may have different effects on competition and the online retailer's profits. In particular, showrooming may very likely increase the online retailer's profits. Second, we have focused on a common and important type of showrooming, where before deciding how to shop, the consumer already knows her object of interest (e.g., through advertisement, word of mouth or seeing others use the product) subject to some match uncertainty. Showrooming is ubiquitous and exists in other forms: (1) Ex ante, the consumer may only realize a general need in a category (e.g., a pair of shoes for autumn) but does not know which specific product she is potentially interested in. In this case, she may need to visit the traditional retailer to identify her favorite product before deciding where to buy. (2) While in a physical store, the consumer may encounter some unplanned interesting items. The where-to-buy decision of such impulse items is especially relevant in the age of wireless Internet. Both scenarios are worth future investigation.

Our analysis still has limitations. First, we assume that one traditional retailer competes with only one online retailer. Although a traditional retailer may enjoy some local market power, in many categories the consumer easily finds multiple online retailers. Future research may examine the case with multiple online retailers. Second, we assume that the two firms have an identical marginal cost, although traditional retailers tend to have higher marginal costs in some markets. It is worth exploring how unequal costs affect the traditional retailer's incentive to add an online channel and to price match and the online retailer's incentive to allow product returns. However, we expect our results to hold for limited cost difference. Besides, Section 5.2 assumes that the consumer may return a product for a full refund at no extra cost. This can be relaxed by allowing the online retailer to charge a restocking fee. Section 5.3 assumes that all consumers are aware of the price-matching guarantee. Future research may examine the case of incomplete awareness. Last, our analysis of webrooming is still exploratory, especially when it partially resolves match uncertainty. This type of webrooming is rather common and deserves further investigation.

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Appendix

Proposition A.1. *Suppose firm T also sells online at price p_O. Case* (1). *When $0 < s \le (1-\lambda)(\theta-1)/(6\theta)$, the unique equilibrium is $p_E = (\theta-1)/(3\theta)$, $p_O = (\theta-1)/(6\theta)$, and $p_T = (4\theta-1)/(6\theta)$. Case* (2). *When $(1-\lambda)(2\theta-1)/(2\theta(2+\lambda)) \le s \le (1-\lambda)(4\theta-1)/(6\theta)$, the unique equilibrium is $p_E = (\theta-1)\cdot(2s+\lambda)/(4\theta-1-\lambda(\theta-1))$, $p_O = (\theta-1)(2s+\lambda)/(2[4\theta-1-\lambda(\theta-1)])$, and $p_T = (4(\theta-1)+2(\theta-1)s)/(2[4\theta-1-\lambda(\theta-1)])$. Case* (3). *When $(1-\lambda)(4\theta-1)/(\lambda(4\theta-1)+(2\theta+1)) \le s \le (4\theta-1)/(2\theta+1)$, the unique equilibrium is $p_E = (\theta-1)(1+s)/(3\theta)$, $p_O = (\theta-1)(1+s)/(6\theta)$, and $p_T = ((4\theta-1)-(2\theta+1)s)/(6\lambda\theta)$.*

Proof. The deduction of the equilibrium closely parallels that of the basic model and has three cases. When search cost is low ($p_O \ge s/(1-\lambda)$), all consumers visit T's physical store first. If realizing a good match, the consumers in $[0, (p_E-p_O)/(\theta-1)]$ buy from T online, those in $((p_E-p_O)/(\theta-1), p_T-p_E]$ buy from E, and those in $(p_T-p_E, 1]$ buy from T's physical store. The two firms' profit functions are $\pi_T = \lambda(p_E-p_O)p_O/(\theta-1)+\lambda(1-p_T+p_E)p_T$ and $\pi_E = \lambda(p_T-p_E-(p_E-p_O)/(\theta-1))p_E$. When $s \le (1-\lambda)(\theta-1)/(6\theta)$, we can verify that $p_E = (\theta-1)/(3\theta)$, $p_O = (\theta-1)/(6\theta)$, and $p_T = (4\theta-1)/(6\theta)$ are indeed an equilibrium, where $\pi_T = (\lambda(\theta-1)+\lambda(4\theta-1)^2)/(36\theta^2)$ and $\pi_E = \lambda(\theta-1)/(9\theta)$.

When search cost is intermediate ($p_T \ge s/(1-\lambda) \ge p_E$), consumers in $[0, (p_E-p_O)/(\theta-1)]$ will make uninformed purchases from T online, those in $((p_E-p_O)/(\theta-1), s/(1-\lambda)-p_E]$ will make uninformed purchases from E, and the remaining will visit T's physical store first. If realizing a good match, those in $(s/(1-\lambda)-p_E, p_T-p_E]$ will buy from E and those in $(p_T-p_E, 1]$ buy from T's physical store. Firm E's demand is $(s/(1-\lambda)-p_E-(p_E-p_O)/(\theta-1)) + \lambda(p_T-s/(1-\lambda)) = \lambda p_T + s - (\theta p_E - p_O)/(\theta-1)$. The firms' profit functions are $\pi_T = (p_E-p_O)p_O/(\theta-1)+\lambda(1-p_T+p_E)p_T$ and $\pi_E = (\lambda p_T + s - (\theta p_E - p_O)/(\theta-1))p_E$. When $(1-\lambda)(2\theta-1)/(2\theta(2+\lambda)) \le s \le (1-\lambda)(4\theta-1)/(6\theta)$, we can verify that $p_E = (\theta-1)(2s+\lambda)/(4\theta-1-\lambda(\theta-1))$, $p_O = (\theta-1)(2s+\lambda)/(2[4\theta-1-\lambda(\theta-1)])$, and $p_T = (4(\theta-1)+2(\theta-1)s)/(2[4\theta-1-\lambda(\theta-1)])$ form an equilibrium.

When search cost is high ($p_T \le s/(1-\lambda)$), showrooming does not arise. The consumers in $[0, (p_E-p_O)/(\theta-1)]$ will make uninformed purchases from T online, $((p_E-p_O)/(\theta-1), \lambda p_T - p_E + s]$ make uninformed purchases from E, and $(\lambda p_T - p_E + s, 1]$ make informed purchases from T's physical store. The firms' profit functions are $\pi_T = (p_E-p_O)p_O/(\theta-1) + \lambda(1-\lambda p_T+p_E-s)p_T$ and $\pi_E = (\lambda p_T - p_E + s - (p_E-p_O)/(\theta-1))p_E$. When $(1-\lambda)(4\theta-1)/(\lambda(4\theta-1)+(2\theta+1)) \le s \le (4\theta-1)/(2\theta+1)$, we can verify that $p_E = (\theta-1)(1+s)/(3\theta)$, $p_O = (\theta-1)(1+s)/(6\theta)$, and $p_T = ((4\theta-1)-(2\theta+1)s)/(6\lambda\theta)$ form an equilibrium. Because the parameter conditions for the three cases do not overlap, the equilibrium in each case is thus unique. Q.E.D.

Proof of Proposition 3. In Case (1), with the online channel T makes profits $\pi_T = (\lambda(\theta-1)+\lambda(4\theta-1)^2)/(36\theta^2) < 4\lambda/9$. In Case (2), with the online channel T's profits are $\pi_T = ((\theta-1)\cdot(2s+\lambda)^2 + \lambda[4\theta-1+2(\theta-1)s]^2)/(4[4\theta-1-\lambda(\theta-1)]^2)$. Firm T's profits without the online channel are $\lambda(2+s)^2/((4-\lambda)^2)$. We have $\lim_{\lambda\to 0}\pi_T = (\theta-1)s^2/(4\theta-1)^2 > \lim_{\lambda\to 0}(\lambda(2+s)^2/(4-\lambda)^2) = 0$ and $\lim_{\lambda\to 1}\pi_T < \lim_{\lambda\to 1}\lambda\cdot(2+s)^2/(4-\lambda)^2 \Leftrightarrow 4s^2+16s+7>0$, which clearly holds. Since T's profits are continuous in λ, the online channel increases T's profits when λ is sufficiently small and lowers its profits when λ is sufficiently large. In Case (3), T's profits with the online channel are $\pi_T = ((\theta+1)(1+s)^2+[4\theta-1-(2\theta+1)s]^2)/(36\theta^2)$. Adding the online channel increases T's profits when $\pi_T > (2-s)^2/9 \Leftrightarrow s > (7\theta-2)/(5\theta+2)$, and decreases its profits otherwise. Q.E.D.

Proposition A.2. *Suppose firm E offers a returns policy. When $s \le (1-\lambda)[2\lambda-3(1-\lambda)d]/(3(1+\lambda))$, the unique equilibrium is $p_T = 2/3$ and $p_E = 1/3$. When $(1-\lambda)[2+(1-\lambda)d]/(1+5\lambda) \le s \le 2+(1-\lambda)d$, the unique equilibrium is $p_T = (2-s+(1-\lambda)d)/(3\lambda)$ and $p_E = (1+s+2(1-\lambda)d)/(3\lambda)$.*

Proof. To derive the equilibrium, we separately consider two cases.

Case (1): $s/(1-\lambda) < p_T - p_E$.

In this case, we have $s/(1-\lambda) < s + \lambda(p_T - p_E) < p_T - p_E$. The returns policy curtails but does not eliminate showrooming in this case. The consumers in $[0, s/(1-\lambda)]$ order directly from E and will return the product in case of a mismatch, each contributing an expected margin $\lambda p_E - (1-\lambda)d$. The consumers in $[s/(1-\lambda), p_T - p_E]$ order from E after showrooming, and those in $[p_T - p_E, 1]$ make informed purchases from T. Firm E's profit function is $\pi_E = s/(1-\lambda)[\lambda p_E - (1-\lambda)d] + \lambda(p_T - p_E - s/(1-\lambda))p_E = \lambda(p_T - p_E)p_E - sd$ and that of T is $\pi_T = \lambda(1 - p_T + p_E)p_T$. The FOCs jointly lead to $p_T = 2/3$ and $p_E = 1/3$. When $s \le (1-\lambda)[2\lambda - 3(1-\lambda)d]/(3(1+\lambda))$, we can verify that neither firm will unilaterally deviate and these prices are an equilibrium. The firms make profits $\pi_T = 4\lambda/9$ and $\pi_E = \lambda/9 - sd$.

We now verify that neither firm will unilaterally deviate. Clearly, E will not unilaterally deviate to any price below $p_T - s/(1-\lambda) = 2/3 - s/(1-\lambda)$, and T will not deviate to any price above $p_E + s/(1-\lambda) = 1/3 + s/(1-\lambda)$. Suppose E deviates to $p'_E \ge p_T - s/(1-\lambda)$, where $p_T = 2/3$. Then, the consumers in $[0, s + \lambda(p_T - p'_E)]$ will purchase from E and return the product in case of a poor match, and the others will visit and purchase from T in case of a good match. Firm E's profit function is $\pi'_E = [s + \lambda(p_T - p'_E)]\,[\lambda p'_E - (1-\lambda)d]$. When $s \le (1-\lambda)[2\lambda - 3(1-\lambda)d]/(3(1+\lambda))$, E's optimal deviating price is $p'_E = p_T - s/(1-\lambda) = 2/3 - s/(1-\lambda)$, which lowers E's profits.

Suppose T deviates to $p'_T \le p_E + s/(1-\lambda)$, where $p_E = 1/3$. The consumers in $[s + \lambda(p'_T - p_E), 1]$ will visit T and purchase from T in case of a good match, and the others will purchase directly from E. Firm T's profit function is $\pi'_T = \lambda[1 - s - \lambda(p'_T - p_E)]p'_T$. When $s \le (1-\lambda)[2\lambda - 3(1-\lambda)d]/(3(1+\lambda))$, T's optimal deviating price is $p'_T = p_E + s/(1-\lambda) = 1/3 + s/(1-\lambda)$, which lowers T's profits.

Case (2): $s/(1-\lambda) \ge p_T - p_E$.

Firm E's returns policy fully eliminates showrooming in this case. The consumers in $[0, s + \lambda(p_T - p_E)]$ purchase from E and invoke its returns policy in case of a poor match. The remaining consumers make informed purchases T. Firms T and E's profit functions are $\pi_T = \lambda[1 - s - \lambda(p_T - p_E)]p_T$ and $\pi_E = [s + \lambda(p_T - p_E)][\lambda p_E - (1-\lambda)d]$, respectively. The FOCs lead to $p_T = (2 - s + (1-\lambda)d)/(3\lambda)$ and $p_E = (1 + s + 2(1-\lambda)d)/(3\lambda)$. When $(1-\lambda)[2 + (1-\lambda)d]/(1+5\lambda) \le s \le 2 + (1-\lambda)d$, we can verify that neither firm will unilaterally deviate and these prices form an equilibrium. The firms make profits $\pi_T = [2 - s + (1-\lambda)d]^2/9$ and $\pi_E = [1 + s - (1-\lambda)d]^2/9$.

We now verify that neither firm will unilaterally deviate. In this case, by construction E will not unilaterally deviate to any price above $p_T - s/(1-\lambda) = (2 - s + (1-\lambda)d)/(3\lambda) - s/(1-\lambda)$, and T will not deviate to any price below $p_E + s/(1-\lambda) = (1 + s + 2(1-\lambda)d)/(3\lambda) + s/(1-\lambda)$. Suppose E deviates to $p'_E \le p_T - s/(1-\lambda)$, where $p_T = (2 - s + (1-\lambda)d)/(3\lambda)$. Then, the consumers in $[0, s/(1-\lambda) - p'_E]$ will purchase directly from E (and return the product in case of a poor match), consumers in $[s/(1-\lambda) - p'_E, p_T - p'_E]$ will do showrooming. Firm E's profit function is $\pi'_E = \lambda(p_T - p'_E)p'_E - sd$. When $s \ge (1-\lambda)[2 + (1-\lambda)d]/(1+5\lambda)$, E's optimal deviating price is $p'_E = p_T - s/(1-\lambda)$, which lowers its profits.

Suppose T deviates to $p'_T \ge p_E + s/(1-\lambda)$, where $p_E = (1 + s + 2(1-\lambda)d)/(3\lambda)$. Then, consumers in $[p'_T - p_E, 1]$ will make informed purchases from T, and T's profit function becomes $\pi'_T = \lambda(1 - p'_T + p_E)p'_T$. When $s \ge (1-\lambda)[2 + (1-\lambda)d]/(1+5\lambda)$, T's optimal deviating price is $p'_T = p_E + s/(1-\lambda)$, which lowers its profits. Q.E.D.

Proposition A.3. *Case* (1). *When* $s \le \lambda(1-\lambda)/(3\lambda + 2(1-\lambda)\alpha)$, *the unique price equilibrium is* $p_T = 2/3$ *and* $p_E = 1/3$, *where* $\pi_T = 4\lambda/9$ *and* $\pi_E = \lambda/9$. *Case* (2). *When* $(1-\lambda)/3 \le s \le 2(1-\lambda)/3$, *the unique price equilibrium is* $p_T = (2\lambda + [2(1-\lambda) + s]\alpha)/(3\lambda + 4(1-\lambda)\alpha)$ *and* $p_E = (\lambda + 2\alpha s)/(3\lambda + 4(1-\lambda)\alpha)$, *where* $\pi_T = \lambda(p_T)^2$ *and* $\pi_E = [\lambda + (1-\lambda)\alpha]p_E^2$. *Case* (3). *When* $2(1-\lambda)[\lambda + (1-\lambda)\alpha]/(3\lambda + (1-\lambda)[1 + 2(1-\lambda)(1-\alpha)]\alpha) < s < 2[\lambda + (1-\lambda)\alpha]/(2[\lambda + (1-\lambda)\alpha]\alpha - \alpha)$, *the unique price equilibrium is* $p_T = (\alpha s + 2[\lambda + (1-\lambda)\alpha](1 - \alpha s))/(3\lambda + 4(1-\lambda)^2(1-\alpha)\alpha)$ *and* $p_E = (\lambda + [2 - \lambda - 2(1-\lambda)\alpha]\alpha s)/(3\lambda + 4(1-\lambda)^2(1-\alpha)\alpha)$, *where* $\pi_T = \lambda[1 - (1-\lambda)\alpha](p_T)^2$ *and* $\pi_E = [\lambda + (1-\lambda)\alpha](p_E)^2$.

Proof. The proof closely parallels the deduction of price equilibrium in Section 4 and thus is omitted.

Endnotes

[1] Because every shopper can enjoy the presale service regardless of purchase, improving presale service amounts to lowering consumer search costs (Iyer and Kuksov 2012).

[2] For instance, consumers are often not equally skilled in navigating through the website, not equally comfortable in making a payment online, and not equally patient when waiting for the order to arrive.

[3] In categories where consumers are reluctant to make uninformed purchases (e.g., certain expensive durables such as cars), showrooming can easily increase the online retailer's profits.

[4] The analysis does not change if, after arriving at the store, the consumer incurs a relatively small cost to inspect the product because she will always choose to inspect the product.

[5] Section 5.5 examines the case with heterogeneous travel costs.

[6] When $\lambda(1-\lambda)/(2+\lambda) < s \le (1-\lambda)/3$ or $2(1-\lambda)/3 < s < 2(1-\lambda)/(1+2\lambda)$, there is no pure-strategy equilibrium.

[7] We do not have direct evidence that lowering search costs hurts retailer profits. This is partly complicated by the fact that many retailers carry products prone to showrooming and convenience, experience or packaged goods (not prone to showrooming) (e.g., Walmart and Target) as well as third-party brands and private and exclusive brands (e.g., Macy's and Kohl's). Although lowering search cost may hurt retailer profits from items subject to showrooming, it may increase its profits from the convenience and experience items and private and exclusive brands.

[8] In categories where match is highly important and people are hesitant to make uninformed purchases (e.g., certain expensive durables such as cars, furniture sets for the living room, etc.), showrooming easily increases the online retailer's profits.

[9] Section 5.4 shows that the equilibrium in Cases (1) and (2) continues to hold even if ex ante she does not observe the physical retailer's price.

[10] Accounting for the fixed costs of the online channel does not alter the spirit of this analysis.

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