Distracted from Comparison: Product Design and Advertisement with Limited Attention*

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Abstract

We study how firms choose designs—of products or information—to direct consumers' limited attention. Consumers with limited attention either study fewer products carefully to learn match values, or superficially browse prices of more products. We highlight a novel distraction effect: to distract consumers from price-comparison, firms combine larger prices with designs that disperse match values. Thus, firms disclose excessively-detailed product information: information improves matches, but distracts consumers from price-comparison, relaxing competition. If consumer attention is sufficiently scarce, more-detailed information harms consumers. In contrast, interventions towards coarser and easily-available information—e.g. front-package-food labels like nutriscores—increase competition.

Keywords: Limited attention, product design, information design, product labels, consumer protection

JEL codes: D83, L13, L15

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1 Introduction

Consumers have limited attention (Malmendier and Lee, 2011; Kling et al., 2012; Heiss et al., 2019, etc) , so they must choose which aspects of their environment they pay attention to. Especially when shopping for many of today's complex products, consumers with limited attention have to decide whether to study fewer products in detail to learn if they fit their taste, or superficially compare a wider range of products by only looking at their prices. For example, a consumer looking for a car could spend their time comparing prices of different sellers, or instead focus on fewer cars and think more carefully about which design or safety feature they like best and how to optimally use it. Similarly, a grocery shopper might focus attention on flavor, nutrients, and ingredients of some selected options, or compare prices of a wider range of alternatives. Because consumer attention is so essential, sellers influence what consumers pay attention to, using product labels (Dubois et al., 2021; Crosetto et al., 2020), advertisements (Dubois et al., 2018), and other design features. In this article, we explore how consumers allocate their limited attention between depth and breadth. We then explore how firms design products or disclose product information to captivate consumers' attention and weaken competition.

To approach these issues we combine recent work on consumers with limited attention, and design choices of firms. First, we build on Heidhues et al. (2021) and model limited attention as a trade-off between depths and breadth of search. But in our setting, firms can use designs to influence more directly what consumers pay attention to. Second, we model such designs based on Johnson and Myatt (2006): firms choose a design to influence the dispersion of consumers' match values. Designs can disperse consumers' match values and induce more extreme opinions about the products, which we call niche designs. Reversely, designs can compress match values, capturing that opinions are less divided about the product, which we call mass-market designs. This notion of design is quite abstract, but it captures, for example, (i) that firms select product attributes about which consumers' opinions are more or less divided, or, as in our leading examples, (ii) that firms make more-precise product information available. For example, when food packages depict nutrients and ingredients, consumers who pay attention to them can apply their preferences to these information, dispersing match values. With less or more vague information, consumers learn less about their match values and they would be more compressed.

We illustrate our key novel mechanism in a baseline model. Two firms choose their price and design to compete for a unit mass of consumers. Initially, consumers observe the price of one of the two firms with equal probability. To model the trade-off between depths and breadth in this setting, consumers decide whether to study the match value of their initially-assigned firm, or instead browse and compare the price of the other firm. Thus, how consumers allocate their attention influences how they perceive product differentiation. Studying consumers learn all details of a product and purchase only if their match value is sufficiently large, while browsing consumers do not learn the products' details and are more price sensitive.

We consider two types of consumers to capture heterogeneity in how consumers trade-off product fit and prices. Bargain shoppers have the same match value for all products. They only care about prices and have sufficient attention to browse prices of both firms. The remaining consumers are value shoppers. Because of limited attention, they trade-off studying the match value of one product to find a good match with browsing to save money. We show that value shoppers study if i) the price they observe initially is not too large and—crucially—ii) match values are sufficiently dispersed. The reason for the second channel is that niche designs increase the cost of a mismatch, i.e. a product value below price, which encourages consumers to study.

This insight leads to the key novel mechanism driving our results—the distraction effect: Browsing consumers may find a cheaper product elsewhere, which is why firms that charge large prices want to discourage browsing. Indeed, firms can distract value shoppers from browsing by combining large prices with dispersed match values. Dispersed match values increase the harm from a mismatch, which encourages value shoppers to study to avoid a mismatch. But when value shoppers study match values, they have less attention left to browse prices. This way, dispersed match values distract value shoppers from comparison shopping and make them less price sensitive.

The distraction effect implies that firms combine niche designs with large prices. But firms also have incentives to charge low prices to compete for bargain shoppers and browsing value shoppers. In equilibrium, firms balance this trade-off by playing mixed price strategies. In addition, firms combine low prices with mass-market designs: When a firm charges a low price, browsing value shoppers are unlikely to find a cheaper product; but if value shoppers would study, they might find out the product is a mismatch and not buy. Overall, firms combine large prices with niche designs to distract consumers from price comparison, and low prices with mass-market designs to encourage price comparison.

More-niche designs might become available, e.g. because of innovations or deregulation of product design, because advances in information technology allow firms to disclose product information more effectively, or because regulation requires firms to disclose information in a certain way. The distraction effect has important implications for how more-niche designs affect consumer surplus. Fixing prices and search behavior—more niche designs allow studying value shoppers to find better matches and increase consumer surplus. This captures the classic intuition that informative ads benefit consumers (Bagwell, 2007; Nelson, 1974). In our baseline equilibrium, however, more-niche designs reinforce the distraction effect: consumers do less comparison shopping, which leads firms to raise prices and reduces consumer surplus.

We extend our baseline model and allow (i) for wider families of match-value distributions, and (ii) relax how we model limited attention and allow consumers to browse and/or study more firms. The key novelty is that as consumers can search more firms, their outside option improves. Nonetheless, we show that the distraction effect generalizes to this setting.

Additionally, allowing consumers to browse and study more firms allows us to illustrate more precisely when more-niche designs harm or benefit consumers. More-dispersed match values have two effects in equilibrium: First, according to the distraction effect, consumers are more inclined to allocate a given amount of attention towards studying, which relaxes competition. Second, more dispersion encourages consumers to search on and consider more firms, which can improve match values and reinforce competition. If attention is abundant, the second effect can dominate, and the overall effect on consumer surplus is ambiguous. But we show that if attention is scarce, the distraction effect dominates: more dispersion relaxes competition and harms consumers.

Our results have implications for various firm strategies and how they affect consumer attention. First, in an extension on brand proliferation, we show that firms may make many product varieties available to distract consumers. Thus, our results extend to settings like electronic appliances or food items that come in many varieties.

Second, consider our main application where niche designs result from detailed product information. Our results suggest that if consumer attention is sufficiently limited, firms make too-detailed information available to distract consumers from product comparison; this relaxes competition and lowers consumer surplus. Instead, coarser information would reinforce comparison shopping and benefit consumers

Third, via the distraction effect, firms exploit limited attention to raise prices. Thus, firms may want to deliberately congest consumer attention. We explore this further in an extension and show that firms want to make detailed *but obfuscated* information available that require consumers' attention to be understood. Intuitively, firms obfuscate information to ensure consumers' attention is scarce so that they can exploit the distraction effect. Instead, more easily-available information would encourage comparison and benefit consumers.

Next, we discuss policy implications. Policies that affect information design are used in a wide range of settings like health insurance and treatment, household finance, and retail markets (see Handel and Schwartzstein (2018) for an overview). Our results help understand when and how such policies benefit consumers: if attention is limited, interventions that make more-detailed product information available can backfire and distract consumers from price comparison. Reversely, policies that provide coarser and easily-available, i.e. less obfuscated, product information encourage competition and benefit consumers with limited attention.

These policy implications connect to recent debates about product labels such as front-package food labels (FPFLs) like nutriscores that were permitted in several EU countries.

From a classic economic perspective with unlimited attention it might not be obvious why food labels with coarser information improve choices. But our results suggest that FPFLs make information coarser and more-easily available, and thereby encourage comparison shopping. In line with this prediction, nutriscores and other FPFLs induce healthier food choices (Chantal et al., 2017; De Bauw et al., 2021; De Temmerman et al., 2021; Dubois et al., 2021; Egnell et al., 2019; Hagmann and Siegrist, 2020; Zhu et al., 2016), and reduce retailers' profits-per-capita (Barahona et al., 2021). In addition, labels with coarser information induce healthier food choices than labels with more-detailed information (Crosetto et al., 2020; Dubois et al., 2021; Kiesel and Villas-Boas, 2013). Our results also explain the lobbying effort against nutriscores: in line with our finding that more-detailed information reinforce the distraction effect, firms lobbied against the nutriscores by suggesting food labels with more-detailed information (Julia et al., 2018a,b).

The distraction effect also connects evidence related to pricing, product design and advertisement in various industries. First, exposure to ads on junk food in the UK (Dubois et al., 2018) makes consumers less price sensitive. Exposure—as in our distraction effect—rotates the demand curve, suggesting consumers pay less attention to alternative offers. Second, entrants into the Texan electricity market offer cheaper and simpler contracts with a single rate that encourage comparison (Hortaçsu et al., 2017). Third, in line with our prediction that firms who charge low prices want to encourage price comparison, Pesendorfer (2002) find that retailers regularly advertise discounts and price reductions.

Section 2 discusses our baseline model. In Section 3 we present our main model. Section 4 characterizes equilibrium and the distraction effect in our main model. Section 5 analyzes surplus. Section 6 discusses key modeling assumptions, evidence, and policy implications. Section 7 connects to the related literature, and we conclude in Section 8. Extensions and proofs are in the appendix and web appendix.[1]

2 A Baseline Model

2.1 Setup

We consider a market with two firms who sell a horizontally-differentiated product to a mass 1 of consumers. We denote the price of firm $k \in \{1, 2\}$ by p_k. Firms have the same marginal cost which we normalize to zero.

There are two types of consumers. The share $1 - \alpha$ are bargain shoppers and the remaining share α are value shoppers, where $\alpha \in (0, 1)$. Bargain shoppers enjoy the same match value μ from both products and see them as perfect substitutes. Bargain shoppers stand for rather price-sensitive consumers who care more about getting a cheap deal than

[1]The web appendix is available at https://sites.google.com/site/johannesjohneneconomist/research?authuser=0.

about match values.

Value shoppers care about prices *and* match values. Formally, a value shopper i who buys from firm k enjoys a match value v_{ik}. Match values are randomly distributed and independent across value shoppers and firms, *i.e.*, $v_{ik} \perp v_{i'k}$ and $v_{ik} \perp v_{ik'}$ for $i \neq i'$ and $k \neq k'$. In our baseline model, we assume products are either a good match or a bad match. More precisely, v_{ik} has the following distribution, for all i and $k = 1, 2$,

$$v_{ik} = \begin{cases} \mu + s_k \text{ with probability } \frac{1}{2}, \\ \mu - s_k \text{ with probability } \frac{1}{2}. \end{cases} \tag{1}$$

Firms choose the design $s_k \in [0, \overline{s}]$, where $\overline{s}$ is exogenous. To ease exposition, we restrict attention to[2]

$$\overline{s} > \mu \text{ and } \overline{s} \in \left(\mu(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right], \mu\frac{(4-3\alpha)}{\alpha} \right).$$

These distributions capture a simplified version of demand rotations as introduced by Johnson and Myatt (2006). Firms choose the design s_k to influence the dispersion of match values. We focus on the firms' strategic choice of s_k and assume all designs s_k cost the same. A larger s_k rotates the c.d.f. and disperses match values, corresponding to a more polarising niche product. A smaller s_k compresses the match-value distribution and corresponds to a less-polarising mass-market product. A larger s_k captures that firms use product design over which consumers' preferences are more horizontally differentiated, or disclose more-detailed product information about match values. Johnson and Myatt (2006) discuss micro foundations for these interpretations formally, and we offer an intuitive discussion in Section 6.1.

Limited Attention and Timeline. We build on Heidhues et al. (2021) and model limited attention as a trade-off between depth and breadth with the following sequential game. First, each firm k chooses a design s_k and the price p_k.

Second, each consumer i is independently assigned to one of the two firms with equal probability. Of this initially-assigned firm k, the consumer sees the price p_k and design s_k. That consumers learn prices before they can learn their valuations captures that prices are often more salient or easier to observe.[3] That consumers can observe s_k seems

[2] $\overline{s} > v$ implies that consumption with low match values can be inefficient. When $\overline{s} \notin \left[v(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right], v\frac{(4-3\alpha)}{\alpha}\right]$, some of the comparative statics exhibit weak monotonicity instead of strict monotonicity. Web Appendix C.2 presents results for a wider parameter range.

[3] Prices tags are often salient, also because price-posting laws oblige firms to make them so. A simple extension captures that prices are easier to observe: suppose consumers have two units of attention; browsing costs one unit of attention and studying two units. This does not change equilibrium in the baseline model with two firms. In the main model, this induces fiercer competition, but does not affect the main results qualitatively.

reasonable especially for information design. A consumer may see at a glance how much information is available, say about nutrients or ingredients of food items, but they still need to allocate attention to process it. We can, however, relax this assumption.[4] After observing p_k and s_k, the consumer decides whether to study to learn the match value v_{ik}, or to browse the price p_{-k} of the other firm.[5] To capture limited attention we impose that consumers cannot learn both the match value and the rival's price, and indeed face a trade-off between depth and breadth.

Third, consumers decide whether to purchase a product or to get the outside option that we normalize to zero. Consumers can only buy a product whose price they observe. This ensures consumers need attention to extend their consideration sets.[6]

Equilibrium Restrictions. We look for Perfect Bayesian Equilibria, and restrict our attention to symmetric equilibria where firms adopt the same (possibly mixed) product design and pricing strategy.[7] We make a mild equilibrium-selection assumption. When bargain shoppers are indifferent between browsing prices and studying match values, they browse prices. This rules out Diamond-paradox-type equilibria: without the assumption, there can be equilibria where all consumers study match values and firms charge the monopoly price; but such equilibria are not robust if some consumers started to browse, because firms would start to compete for them, inducing more consumers to browse. We also assume that value shoppers study if they are indifferent.

2.2 Distraction Effect

The equilibrium pins down endogenously how consumers allocate their attention, and how firms choose prices and designs. We first characterize how consumers allocate their attention for given prices and designs.

Bargain shoppers only care about finding the cheapest product, which is why they (weakly) prefer to browse prices. How value shoppers allocate their attention, however, is not straightforward. Value shoppers trade-off browsing to find a bargain and studying to avoid buying a mismatch where $v_{ik} < p_k$. The following lemma characterizes how value shoppers allocate their attention for a given price and design of their initially-assigned

[4]Instead, consumers could form rational beliefs about designs conditional on price. This induces multiple equilibria; but the equilibrium we present here also exists. When consumers cannot observe changes in s, it is harder for firms to redirect attention. We find it reasonable that firms who choose designs to redirect attention would try to make this visible to consumers.

[5]Results are robust to alternative timings. First, cannot benefit from changing designs ex-post. Studying consumers purchase with a large match-value, so designs with less dispersion reduce their demand. Second, firms might choose product designs before prices; then firms may set maximum dispersion with probability one to reinforce the distraction effect.

[6]Otherwise, consumers could buy from a rival without using attention, eliminating the trade-off between browsing and studying.

[7]Johnen and Ronayne (2021) show symmetric equilibria are unique in many models based on Rosenthal (1980) and Varian (1980) if some consumers observe only two prices.

firm and their belief of the price distribution of the other firm, whose c.d.f. we denote $G_{-k}(p_k)$.

Lemma 1. *Consider a value shopper who is initially assigned to firm k, sees $p_k \leq \mu + s_k$ and believes $p_{-k} \sim G_{-k}$ where $G_{-k}(p_k) > 0$ and $G_{-k}(\mu) > 0$.*[8] *For given p_k and G_{-k}, if the value shopper studies the match value for s_k, they study match values for $s_k' > s_k$. Furthermore*

1. *If $s_k \geq \mu$, a value shopper browses prices if and only if p_k is above some threshold $\tilde{p}$.*
2. *If $s_k < \mu$:*[9]
   (a) *either they browse price for all p_k, or*
   (b) *there exists $[\tilde{p}', \tilde{p}]$ such that they browse if and only if $p_k \notin [\tilde{p}', \tilde{p}]$.*

The proof of Lemma 1 and other omitted proofs are in Appendix B. To illustrate, take a value shopper initially assigned to firm 1. The lemma has two main insights for how firm 1 can direct consumer attention. First, a value shopper browses prices when the price they initially observe is sufficiently large. Intuitively, for any non-negative price $p_1 \in (\mu - s_1, \mu + s_1)$ the value shopper may study to avoid a mismatch. But as p_1 increases, the likelihood to find a cheaper product increases and browsing for bargains becomes more attractive. This effect is reminiscent of "competing for consumer inattention" as in De Clippel et al. (2014).

Second, and our key novelty, firm 1 can choose a larger dispersion s_1 to encourage value shoppers to study and thereby discourage comparison shopping. We call this the distraction effect: more dispersion makes mismatches more costly, and to avoid a mismatch, value shoppers need to study. But because value shoppers have limited attention, they can no longer browse and compare alternative offers. In turn, firm 1 can also choose sufficiently small dispersion s_1 to make mismatches less costly and encourage browsing.

We now discuss equilibrium behavior. Unsurprisingly, bargain shoppers browse prices in equilibrium. What is more interesting is how value-shoppers allocate their attention.

In equilibrium, firms positively correlate larger prices with more-niche designs to influence how value shoppers allocate their attention (see Figure 1): consumers who face a large initial price are likely to find a cheaper product if they browse. To prevent these consumers from browsing, firms combine large prices $\overline{p}$ with niche designs $\overline{s}$ to encourage studying and thereby distract value shoppers from price comparison. Using the distraction effect allows firms to charge a larger maximal price in equilibrium.

[8] If $G_{-k}(p_k) = 0$, the value shopper studies following our tie-breaking rule. If $G_{-k}(\mu) = 0$, value shoppers do not browse.

[9] Thus, the match value is always better than the outside option, making browsing more attractive.

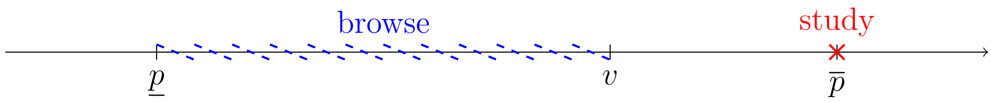

Figure 1: Support of equilibrium prices. Value shoppers study at the price $\overline{p}$ with the red cross and browse in the blue shaded area with dotted lines.

But firms also combine low prices with mass-market designs to encourage comparison shopping. This has two reasons. First, studying makes consumers more skeptical towards product fit: with large dispersion $\overline{s}$, value shoppers who draw a mismatch $v_{ik} = \mu - \overline{s} < 0$ would never buy from their initially-assigned firm, even if the product was for free. Second, value shoppers who draw a low initial price are unlikely to find a cheaper product anyway.

Firms play mixed strategies in equilibrium. Value shoppers who observe $\overline{s}$ and $\overline{p}$ at their initially-assigned firm study and are captive, turning them into the profit base of this firm. Firms, however, also have an incentive to charge low prices to compete for bargain shoppers. But if competition drives prices sufficiently low, firms would benefit from deviating to larger prices with designs $\overline{s}$. This 'Edgeworth cycle' logic (Maskin and Tirole, 1988a,b) leads to mixed-strategy equilibria as in models based on Varian (1980).

The following proposition summarizes these results.

Proposition 1. *Each symmetric equilibrium satisfying the equilibrium-selection assumption has the same price distribution, firms' profit and consumer surplus. Prices are distributed on* $[\underline{p}, \mu] \cup \{\overline{p}\}$*, where* $\overline{p} \in (\mu, \mu + \overline{s})$*. There are no gaps and mass points on* $[\underline{p}, \mu]$*, and there is a mass point on* $\overline{p}$*. Firms mix* $(p, s(p))$*, where* $s(p)$ *follows:*

$$s(p) = \begin{cases} \overline{s} & \text{for } p = \overline{p}, \\ s \in [0, s_p) & \text{for all } p \leq \mu, \end{cases} \tag{2}$$

where $s_p < \overline{s}$ *is the threshold where value shoppers are indifferent between studying and browsing. Each firm earns profits* $\frac{\alpha}{4}\overline{p}$*. Value shoppers who initially draw a high price* $\overline{p}$ *study match values with probability one, and browse with probability one if they draw a low price* $p \in [\underline{p}, \mu]$*; bargain shoppers browse with probability one.*

As we discussed above, the distraction effect determines endogenously the level of and the probability mass on the largest price $\overline{p}$, and therefore also the share of captive value shoppers who pay it. By Equation (2), equilibria feature a positive correlation between prices and the dispersion of match values.[10]

[10]In equilibrium, s only needs to be low enough to induce value shoppers to browse.

2.3 Surplus Analysis

We now explore how changes in $\overline{s}$ affect consumer surplus and firms' profits.

Proposition 2. *If $\overline{s}$ increases, $\overline{p}$ increases and equilibrium prices increase in the sense of F.O.S.D.. Each firm earns larger profits, value shoppers browse with a lower probability, and the surplus of value shoppers and bargain shoppers decreases.*

To understand the proposition, note first that more dispersion can benefit consumers through better matches. We can see this point in our benchmark with full attention. We study this benchmark in detail in Appendix A.1. All consumers are value shoppers and have full attention.[11] Each consumer i observes the realizations of v_{ik} and the price p_k for all firms k. Because consumers have full attention, the benchmark switches off the distraction effect, and only features how more dispersion affects preferences and competition via classic product differentiation: when firm 1 charges its largest equilibrium price, it only sells to value shoppers who draw a low match value of firm 2 and a large match value of firm 1. Firm 1 is effectively the monopolist for these consumers. A larger $\overline{s}$ makes firm 1 more attractive for these consumers, which firm 1 can (partially) extract by increasing its prices. Crucially, these price increases are limited by the additional value generated through the larger $\overline{s}$, which is why consumer surplus does not decrease.

Based on this argument, one might expect that niche designs benefit consumers. But the argument ignores that consumers may reallocate their limited attention. Indeed, returning to our baseline model with limited attention, Proposition 2 shows that dispersion harms consumers. Intuitively, fixing prices and search strategies, a larger $\overline{s}$ leads to better matches for studying consumers. But a larger $\overline{s}$ also raises the costs of mismatches, which encourages studying and, because attention is limited, leads to less browsing. As a result, a larger $\overline{s}$ reinforces the distraction effect, and leads to larger prices and profits.

This effect is so strong that despite better matches, consumer surplus decreases. First, because prices increase, browsing consumers are clearly worse off. Second, also studying consumers are worse off: in equilibrium, value shoppers who initially draw $(\overline{p}, \overline{s})$ are indifferent between browsing and studying. As $\overline{s}$ increases to $\overline{s}'$, equilibrium prices increase. But since in the new equilibrium, value shoppers who initially draw $(\overline{p}', \overline{s}')$ are again indifferent between browsing and studying, and browsing consumers are clearly worse off with larger prices, they must be worse off also when they study.

3 Main Model

We generalize our baseline model. First, we allow for a wider class of match-value distributions. Second, we relax how we model limited attention so that consumers can browse

[11] With full attention, some consumers draw a good match with both firms. Like bargain shoppers in our baseline model, these consumers only care about prices, inducing price dispersion.

and/or study more firms. Third, we present results for a wider parameter range of $\bar{s}$.

There is a mass 1 of firms indexed by k, who sell a horizontally-differentiated product to a mass 1 of consumers. The price of firm k is p_k. Firms have the same marginal cost which we normalize to zero.

As before, the share $1-\alpha$ of consumers are bargain shoppers who get the match value μ from each product. The remaining share α are value shoppers, where $\alpha \in (0,1)$.

The match value v_{ik} of user i with firm k is randomly distributed and independent across different value shoppers and firms. The match value v_{ik} follows a distribution with c.d.f. F_{s_k}, where for all $s_k \in [0, \bar{s}]$, we have

$$\begin{aligned} & E_{F_{s_k}}(v) = \mu > 0 \\ & \frac{\partial F_{s_k}(v)}{\partial s_k} \lesseqqgtr 0 \quad \text{if and only if} \quad v \gtreqqless \mu, \forall v \in \text{supp}(F_{s_k}). \end{aligned} \tag{3}$$

In other words, F_{s_k} is a family of mean preserving spreads, where a larger s_k denotes a larger spread. Firms choose the design $s_k \in [0, \bar{s}]$, where $\bar{s}$ is exogenous. As in our baseline example, these distributions capture demand rotations as introduced by Johnson and Myatt (2006). Firms choose the design s_k to influence the dispersion of match values. A larger s_k rotates the c.d.f. and disperses match values, corresponding to a more polarizing niche product. As before, we focus on the firms' strategic choice of s_k and assume all designs s_k cost the same. We assume $\text{supp}(F_{\bar{s}}) = [\underline{v}, \bar{v}]$ where $\underline{v} < 0$. We further assume that F_0 is deterministic such that $F_0(v) = 1$ if and only if $v \geq \mu$, and $\lim_{s \to 0} F_s(v) = F_0(v)$ for all v. We assume that $1 - F_s$ is weakly log-concave for all s, and there exists a unique monopoly price when $s = \bar{s}$. We denote $p^M \equiv \arg\max_p (1 - F_{\bar{s}}(p + \delta V))p$ the monopoly price with dispersion $\bar{s}$. We assume F_s is continuous within its support for all s.[12]

Limited Attention and Timeline. We generalize our baseline model of limited attention with the following sequential game with potentially infinite periods. Intuitively, within a search period, consumers have limited attention as in the baseline model, but they can relax their attention constraint and wait for the next search period where more attention may become available.

Formally, in period 0, firms choose s_k and p_k. In period $t \in \{0, 1, \cdots, \infty\}$, consumer i has the consideration set (K_{it}^P, K_{it}^S), where K_{it}^P are all firms in period t of which consumer i knows the price but not the match value, while K_{it}^S are firms in period t that consumer i has studied so that i knows their match values and prices. Thus, $K_{it}^P \cap K_{it}^S = \{\emptyset\}$ for all i and t. In $t = 0$, consumers know no prices or match values and we have $K_{i0}^S = K_{i0}^P = \{\emptyset\}$ for all consumers i. In period $t \in \{1, \cdots, \infty\}$, each consumer i becomes aware of a new

[12] We allow F_s to have mass points at the supremum and infimum of its support to be in line with Assumption 1, which we impose for some results below.

firm k and observes its price p_k and design s_k.[13] Then consumer i decides whether to study k or one of the firms in K_{it}^P, or expand their consideration set by browsing a firm outside of their consideration set. During a search period t, the timeline is as follows:

1. Consumer i starts with $(K_{i(t-1)}^P, K_{i(t-1)}^S)$.
2. Consumer i becomes aware of a new firm $k \notin K_{i(t-1)}^P \cup K_{i(t-1)}^S$ and learns (p_k, s_k). The consumer decides whether to study a firm in $K_{i(t-1)}^P \cup \{k\}$ or browse a firm $k' \notin K_{i(t-1)}^P \cup K_{i(t-1)}^S \cup \{k\}$:
   - if consumer i browses, they learn the price and design $(p_{k'}, s_{k'})$ of a randomly drawn firm $k' \notin K_{i(t-1)}^P \cup K_{i(t-1)}^S \cup \{k\}$ and their consideration set becomes $(K_{it}^P, K_{it}^S) = (K_{i(t-1)}^P \cup \{k, k'\}, K_{i(t-1)}^S)$.
   - if consumer i studies a firm $k'' \in K_{i(t-1)}^P \cup \{k\}$, they learn their match value with firm k'' so that $(K_{it}^P, K_{it}^S) = (K_{i(t-1)}^P \cup \{k\} \setminus \{k''\}, K_{i(t-1)}^S \cup \{k''\})$.
3. Consumer i decides whether to buy a product from their consideration set (K_{it}^P, K_{it}^S), not to purchase, or continue to the next round where new attention becomes available with probability $\delta \in [0, 1]$. If no attention becomes available, their search ends and they get zero payoff.

We assume that the game ends for consumers once they have no attention in a period to simplify exposition of results. Alternatively, we could assume that after a period with no attention, more attention becomes available with probability δ in the next period. But then we would have to introduce a common discount factor strictly below one. Otherwise, consumers would search forever. To avoid adding additional parameters, we make this simplifying assumption instead.[14]

In this framework, consumers trade-off breadth and depth of search within each search period, but we also relax this trade-off so that new attention may become available to consumers. Extending our baseline model this way has several advantages. First, we generalize our baseline model by allowing a consumer to start a new search period that is like the previous one. This captures that attention is limited within a period, but consumers may be able to devote more attention to the issue later. This also ensures the setting has stationary equilibria that are tractable and comparable to our baseline model. Second, δ is the probability that more attention becomes available, e.g. because no other pressing issues come up that require attention.[15] It measures the abundance or

[13] Consumers becoming aware of a new firm each period ensures there is always a firm to study. Our results are also robust if instead have to make an active decision to learn about a new firm.

[14] With this alternative assumption, our result in Propositions 3, 4, and 5 would still hold for a given level of the discount factor if δ is sufficiently small.

[15] δ is exogenous, but we could endogenize it in straightforward ways. E.g. $1-\delta$ is the probability that events come up that require attention, such as a child getting sick, having to work extra hours, needing to devote attention to another market etc.

scarcity of attention. If $\delta \to 0$, the timeline is as in our baseline model and the consumer faces a tight trade-off between breadth and depth of search. As δ increases, it becomes easier for the consumer to spend more attention to study or browse additional firms. If $\delta \to 1$, the consumer no longer needs to trade-off depths and breadth of search: attention is abundant and they can study and browse infinitely many firms.

Equilibrium Restrictions. We look for Perfect Bayesian Equilibria with stationary search strategies such that the continuation payoff of active consumers is invariant in t. Active consumers are those who purchase with strictly positive probability on the path of play. We denote this continuation value if attention is available by V.[16] We restrict our attention to symmetric equilibria where firms adopt the same (possibly mixed) product design and pricing strategy. We make the same equilibrium selection assumptions as in our baseline model.

4 Distract Consumers from Comparison

We first characterize how firms can use prices and designs to influence consumer search, and then analyze equilibrium.

The main difference with respect to Section 2 is that consumers can continue to search, which improves their outside option: in any period t, consumers will only purchase if they get at least the value of searching on, which is δV. For value shoppers, the value of searching on is the same, whether they browsed or studied in the previous period. Thus, their preference between browsing or studying in a given period is unaffected by the value of searching on. This is why many insights from Lemma 1 extend to this setting.

The following Lemma characterizes how an individual firm can influence how value-shoppers search. Thus, in the lemma we suppose V is constant. We verify below that this is indeed the case in equilibrium. We also drop period-superscripts t to simplify notation.

Lemma 2. *Suppose the continuation value V is constant in period t. Consider a value shopper who decided to search on in period $t-1$, has attention at the beginning of period t, and is matched with firm k and observes p_k and s_k. Denote U^k_{study} the utility of studying firm k's product, U_{browse} the utility of browsing, and $G(p)$ the c.d.f. of unknown prices of rivals that value shoppers can browse. Fixing p_k, we have*

$$\frac{\partial(U^k_{study} - U_{browse})}{\partial s_k} > 0 \quad \& \quad \frac{\partial(U^k_{study} - U^{k'}_{study})}{\partial s_k} > 0, \tag{4}$$

for all $s_k < \overline{s}$ and any not-studied firm $k' \neq k$ in the consideration set. Furthermore, for a fixed s_k, when $G(\mu - \delta V) > 0$, $U^k_{study} < U_{browse}$ if p_k is sufficiently large.

[16] In some equilibria, bargain shoppers are inactive and purchase with probability zero. In that case, they will have a different continuation value than V.

Lemma 2 generalizes results from Lemma 1. Take a consumer who observes (p_k, s_k) at the beginning of period t. First, mirroring the above "competition for inattention", if p_k is sufficiently high, the consumer prefers browsing over studying k.

Second, firms can use the distraction effect: firm k can increase dispersion s_k to encourage consumers to study match values. As before, the main benefit of studying firm k is to avoid a mismatch. Also with this class of match-value distributions, a mean-preserving spread (larger s_k) increases the loss from a mismatches. More formally, $\mathbb{E}[v_{ik}|v_{ik} < p_k]$ decreases in s_k. To see this, consider first $p_k < \mu - \delta V$, i.e. the studying value shopper who is indifferent between purchasing and searching on sits below the rotation point μ. In this case, more dispersion shifts probability mass of match values downwards below p_k, and the result follows immediately. For $p_k > \mu - \delta V$, more dispersion decreases the probability mass of match values below p_k; but because dispersion is a mean-preserving spread, the expected match value conditional on $v_{ik} < p_k$ must decrease. See Figure 2 for an illustration. Thus, more dispersion encourages value shoppers to study firm k in period t; this leaves consumers with less attention to browse and compare alternative offers in period t, or—new in this setting—to study another firm k'.

Thus, the key insights from Lemma 1 extend to this setting. We now use these insights to characterize equilibrium.

Using Lemma 2, we can show the following general result when consumer attention is scarce. We denote $\overline{p}$ and $\underline{p}$ as the supremum and infimum price in the equilibrium support.

Proposition 3. *If δ is sufficiently close to zero, in any symmetric stationary equilibrium that satisfies our selection assumption, the following statements hold.*

- *If $\overline{p} = \underline{p}$, firms choose $s = \overline{s}$ with probability 1 and value shoppers study. Otherwise, there exists a $\hat{p}$ such that firms choose a sufficiently large s such that value shoppers study with probability one if $p \geq \hat{p}$.*
- *If $\overline{p} < \mu - \delta V$, then firms may charge $s' \in (0, \overline{s})$ at $\overline{p}$. Otherwise, firms charge $\overline{s}$ at $\overline{p}$.*

The proposition has two main implications. First, if attention is scarce, i.e. δ is small, the distraction effect drives pricing more generally than in the baseline model: firms induce studying and exploit the distraction effect when they charge large prices. By doing so, they discourage product comparison and soften competition. More precisely, if $\overline{p} < \mu - \delta V$, then the studying value shopper who is indifferent between purchasing at $\overline{p}$ and searching on is below the rotation point μ. In this case, firms prefer lower dispersion at the monopoly price to raise demand. In Johnson and Myatt (2006), this is why firms would choose minimal dispersion. But due to our distraction effect, firms

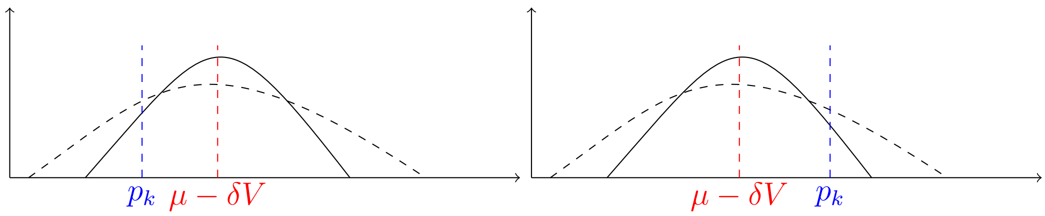

Figure 2: Probability density functions of match values. The black dashed line is a mean preserving spread of the black line. Left: $p_k < \mu - \delta V$. Right: $p_k > \mu - \delta V$.

need to induce studying at $\overline{p}$ to be able to sell to value shoppers in the first place. To balance this trade-off, firms set the lowest dispersion that is still large enough to make sure value shoppers study at $\overline{p}$. If $\overline{s}$ is sufficiently large, we can then have $s' < \overline{s}$. In all other cases, the distraction effect fully dominates other considerations and firms charge $\overline{s}$ at $\overline{p}$. Thus, in general, firms induce studying and exploit the distraction effect when they charge large prices.

Second, in general it is difficult to fully characterize equilibrium. The key issue is that firms may want to induce browsing and studying for different sub intervals of prices below $\hat{p}$: Firms are constrained by consumer choices we characterize in Lemma 2. But subject to these constraints, firms want to induce value shoppers to browse or study based on what maximizes demand from these consumers. If there exists an s_k such that consumers want to study and $1 - F_{s_k}(p_k) \geq 1 - G(p_k)$, firm k that charges p_k prefers to induce value shoppers to study; otherwise firm k prefers value shoppers to browse. But for this class of mean-preserving spreads, both the equilibrium price distribution $G(\cdot)$ and the demand from studying value shoppers $F_{s_k}(\cdot)$ are strictly increasing for prices below $\hat{p}$ and may intersect multiple times. Thus, firms may want to induce browsing and studying for different sub intervals below $\hat{p}$, based on what maximizes demand. Figure 3 illustrates an example.

Even though our main effect is robust and firms exploit the distraction effect for large prices, this issue makes it difficult to fully characterize equilibrium. This is why we introduce an additional assumption. We denote $\text{supp}(F_{s_k}) = [\underline{v}_{s_k}, \overline{v}_{s_k}]$.

Assumption 1. *$\underline{v}_{s_k} = \mu - s_k$, $\overline{v}_{s_k} = \mu + s_k$, and $Prob(v < \mu + s_k) - Prob(v \leq \mu - s_k) < \xi$.*

Assumption 1 ensures that the c.d.f.'s of the mean-preserving spreads do not increase too fast for medium prices. It guarantees this by imposing that the mean-preserving spreads are sufficiently close to bimodal distributions. This guarantees that value shoppers study in equilibrium if and only if $p \geq \hat{p}$, and browse otherwise.

We now use this assumption and characterize consumer search in equilibrium. Bargain shoppers do not benefit from studying, which is why in any equilibrium where they purchase with strictly positive probability, they browse. We now characterize how value

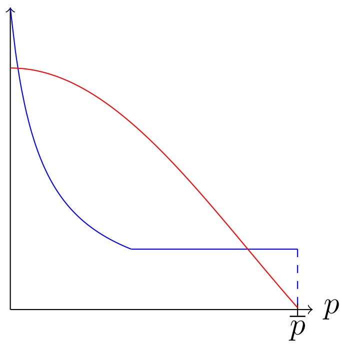

Figure 3: The blue curve is $1 - G(\cdot)$, and the red curve $1 - F_{s_k}(\cdot)$. For a fixed s_k, firm k would prefer to induce browsing for small prices to the left of the first intersection, then studying between the first and second intersection, then browsing between the second and third intersection, and then studying at $\hat{p} = \overline{p}$.

shoppers search in equilibrium. First, as is standard in sequential search problems, value shoppers use reservation-price search rules. In a period t, a value shopper purchases from a firm k in her consideration set if the offer is sufficiently beneficial; otherwise they prefer to continue searching over buying from k in period t and any future period. Second, if a value shopper considers a firm k at the beginning of period t, and they choose to browse, they will never study firm k. This rules out that a value shopper browses for a while and then returns to firm k later to study it. Intuitively, firm k prefers consumers to study k when they encounter it for the first time; other strategies that involve searching more firms reduce demand.

Thus, as in our baseline model, firms exploit the distraction effect: they combine large prices above a cutoff $\hat{p}$ with niche designs to discourage comparison, and low prices below $\hat{p}$ with mass-market designs to ensure value shoppers do not detect a mismatch. Consequently, (i) demand is less elastic for prices above $\hat{p}$, and (ii) the probability mass of prices above $\hat{p}$ determines how many value shoppers study and are captive.

We now describe in more detail how firms choose prices and designs in equilibrium. The price distribution is qualitatively different, depending on how much dispersion $\overline{s}$ is possible. For $\overline{s} \leq \overline{s}_L$ all prices are weakly below $\mu - \delta V$, which is why browsing consumers purchase for all equilibrium prices. For prices above $\hat{p} \in \left(\underline{p}, \overline{p}\right)$, bargain shoppers browse and value shoppers study.

For $\overline{s} \in (\overline{s}_L, \overline{s}_H)$, we have $\overline{p} > \mu - \delta V > \underline{p}$ the price distribution closely resembles those from our baseline model. Clearly, for prices above $\mu - \delta V$, consumers only purchase if they study and get a sufficiently-good match. This is why firms that charge such prices face very inelastic demand and shift all probability mass of prices above $\mu - \delta V$ to $\overline{p}$, the price at which value shoppers are indifferent between studying or browsing with maximal dispersion $\overline{s}$.[17]

[17]More precisely, $\overline{p}$ is the largest price at which value shoppers study, and is below the monopoly price

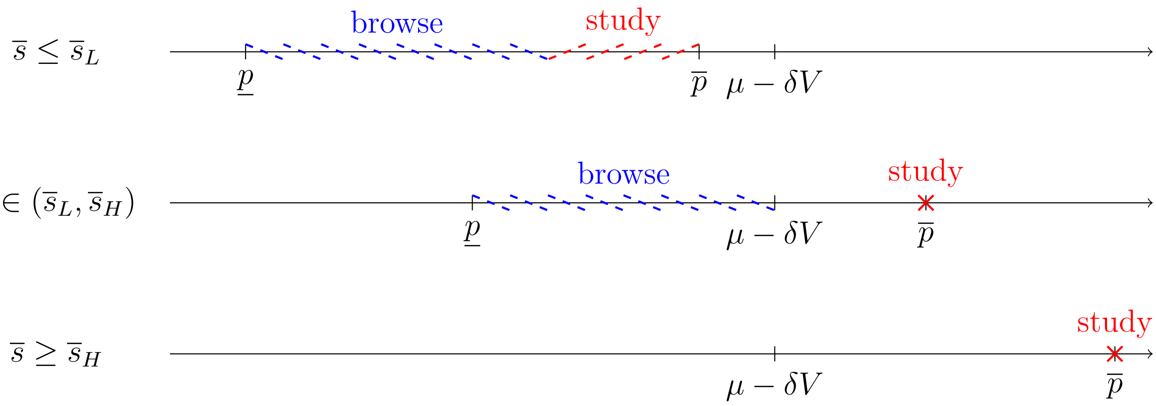

Figure 4: The support of equilibrium prices depending on $\overline{s}$. Value shoppers study match values for the prices in the red shaded area and browse prices in blue shaded area.

For $\overline{s} \ge \overline{s}_H$, we have $\underline{p} > \mu - \delta V$. Prices are now so large that bargain shoppers do not purchase and firms prefer not to compete for them.[18] In this scenario, firms distract value shoppers so successfully that they strictly prefer to study until they find a sufficiently-good match. As a result, firms price like monopolists and charge p^M. In this scenario, we necessarily have that $p^M > \mu - \delta V$, which is why, as shown by Johnson and Myatt (2006), firms choose maximal dispersion to raise demand.

Note that for any $\overline{s} < \overline{s}_H$, value shoppers who study are always indifferent between browsing and studying.[19] This is why bargain and value shoppers have the same consumer surplus and the same continuation value V in equilibrium. For $\overline{s} \ge \overline{s}_H$, however, bargain shoppers purchase with probability zero and choose their outside option.

Figure 4 illustrates these equilibria. The following proposition summarizes results.

Proposition 4. *If δ sufficiently close to zero and Assumption 1 holds, then there exists $\overline{\xi} \in (0, 1)$ such that for all $\xi \le \overline{\xi}$ there exists a unique equilibrium continuation payoff V for all consumers who purchase with strictly positive probability; each symmetric and stationary equilibrium has the same price distribution, firms' profit and consumer surplus.*

In equilibrium, there exists $\hat{p}$ such that value shoppers study match values with probability one if and only if $p \ge \hat{p}$ and browse with probability one otherwise; if bargain shoppers purchase in equilibrium, they browse prices with probability one. There exist thresholds $\overline{s}_L$ and $\overline{s}_H > \overline{s}_L$ such that

1. *If $\overline{s} \le \overline{s}_L$, prices are distributed on $[\underline{p}, \overline{p}]$ where $\overline{p} \le \mu - \delta V$.*

2. *If $\overline{s} \in (\overline{s}_L, \overline{s}_H)$, prices are distributed on $[\underline{p}, \mu - \delta V] \cup \{\overline{p}\}$ where $\overline{p} \in (\mu - \delta V, p^M]$.*

for $\overline{s}$. Because demand is log-concave, $\overline{p}$ therefore maximizes profits from studying consumers.

[18] This equilibrium is robust when all bargain shoppers browse, and therefore does not violate our equilibrium selection assumption.

[19] For $\overline{p} \le \mu - \delta V$, more dispersion lowers demand from studying consumers. Thus, firms will choose the smallest s_k that induces a consumer to study at p_k.

3. If $\overline{s} \geq \overline{s}_H$, firms charge p^M with probability one.

There are no gaps and mass points on prices below $\mu - \delta V$. Firms mix $(p, s(p))$, where

$$s(p) = \begin{cases} s_p & \text{for } p \in [\hat{p}, \overline{p}], \\ s \in [0, s_p) & \text{for all } p \leq \mu - \delta V, \end{cases} \tag{5}$$

where s_p is such that value shoppers are indifferent between studying and browsing, and $s(\overline{p}) = s_{\overline{p}} = \overline{s}$. For $p \in [\hat{p}, \overline{p}]$, $s(p)$ increases in p. Each firm earns strictly positive profits proportional to $\overline{p}(1 - F_{\overline{s}}(\overline{p}))$.

Given parameters α, μ and $\overline{s}$, all symmetric equilibria feature the same profits and price distribution. In Scenarios 1 and 2, equilibria feature a positive correlation between prices and the dispersion of match values.[20] In Scenario 3, firms are monopolists with maximal dispersion $\overline{s}$.

Equilibrium prices and payoffs are uniquely pinned down if δ is sufficiently small, i.e. when attention is rather limited. We discuss evidence in Section 6.1 suggesting that attention is indeed limited in many applications. Note that if δ is sufficiently large, we may have multiple equilibria, but they are one of the three types in Proposition 4.[21]

5 Surplus Analysis

We now explore how changes in $\overline{s}$ affect consumer surplus and firms' profits. As we outline in Section 6, this can occur due to an innovation in production- or information technology, or changes in the regulation of products or advertisements.

We want to understand how changes in $\overline{s}$ affect competition by changing how consumers search, so we focus on Scenarios 1 and 2, i.e. $\overline{s} < \overline{s}_H$. For $\overline{s} \geq \overline{s}_H$, firms are monopolists and small changes in dispersion do not affect how consumers search.

Proposition 5. *Suppose $\overline{s} < \overline{s}_H$, Assumption 1 holds and $\xi \leq \overline{\xi}$. There exists $\overline{\delta}$ such that when $\delta < \overline{\delta}$, an increase in $\overline{s}$ leads to a strictly lower surplus for value and bargain shoppers, strictly larger profits for each firm, and value shoppers study with a strictly higher probability in each period. For $\delta \geq \overline{\delta}$, there can exist equilibria where an increase in $\overline{s}$ can increase the surplus for value and bargain shoppers.*

[20] Low s are not uniquely pinned down for the same reason as in Proposition 1.

[21] The issue is that V pins down the expected value from a purchase, which has an ambiguous effect on prices. First, a larger expected value can make dispersion matter less, which encourages browsing and benefits consumers via lower prices. Second, if many value shoppers study, firms may also raise prices to extract some of the extra value. If δ is small, both effects are negligible. But if δ is large, depending on which of these effects is stronger, we may have multiple equilibria for different values V.

The proposition shows that with abundant attention, more-dispersed match values have an ambiguous effect on consumer surplus. But if attention is scarce, more-dispersed match values harm consumers.

Fixing prices and consumer behavior, more dispersion increases the surplus of studying value shoppers. This changes shopping behavior in two ways: First, as in Proposition 2 mismatches become more costly, so consumers shift a given amount of attention away from browsing towards studying. This is our distraction effect, which leads to larger prices in equilibrium. Second, and novel in this dynamic framework, if the surplus from studying increases, value shoppers with $\delta > 0$ may decide to do more search overall and browse and study more firms. This second effect *can* induce lower prices. Proposition 5 works out that the distraction effect always dominates if attention is sufficiently scarce.

The key novel insight relative to Proposition 2, is that the second effect can dominate and reverse outcomes if consumer attention is abundant, i.e. δ is sufficiently large. Abundant attention relaxes the trade-off between depths and breadth of search: if $\overline{s}$ increases, consumers are more inclined to continue search. If consumers use enough of this additional search for browsing, they mitigate the anti-competitive distraction effect. Indeed, more dispersion $\overline{s}$ can even reinforce competition. As a result, consumers may benefit from more-dispersed match values.

6 Discussions

6.1 Key Modeling Assumptions

We now briefly discuss the two key premises that drive our main results.

Design and Demand Dispersion. A key ingredient is that firms can use designs to influence the dispersion of match values. This is a quite abstract notion of design, but Johnson and Myatt (2006) propose some micro foundations for such demand rotations that help connect the framework to various applications. We discuss these micro foundations here intuitively, and refer to Johnson and Myatt (2006) for a formal discussion.

In our leading interpretation, firms can *make more-precise information available* about their products to disperse match values, i.e. through advertisement, their website, or by training their sales staff. More-precise information about product characteristics allow studying consumers to perceive their match value more precisely: they can apply their preferences to these information, which disperses match values. With less-detailed or vague information, consumers may learn less about their match value, which makes products appear more homogeneous. For example, a food manufacturer can choose how much information on ingredients, health and taste of their products they disclose: information on the amount of fat of a product help consumers identify high- or low fat products, but it does not provide guidance on particular types of fat; more-detailed information would allow consumers to apply their preferences on these information and further disperse match values.

Second, when firms design products, they can *select product attributes* that do not affect quality, but about which consumers' opinions are divided to different degrees. For example, a car manufacturer can offer features that are somewhat ok for many consumers like conservative colors, comfortable and common interiors, or features that are a non-trivial choice and rather targeted at niche audiences like flashy colors, or more sporty or extravagant interiors.

Limited Attention. The other key ingredient is that consumers face a trade-off between breadth and depths of search. This is in line with the perspective by Mullainathan and Shafir (2013) that the cognitive capacity of humans is scarce, so they must decide which aspects of their environment to pay attention to. Altmann et al. (2022), Malmendier and Lee (2011), and Kling et al. (2012) provide evidence for scarce cognitive capacity. Kling et al. (2012) find that consumers ignore even readily-available information, which also underlines the key importance of attracting attention. That people allocate attention strategically is documented by Bartoš et al. (2016), and in experimental settings (Gabaix et al., 2006; Altmann et al., 2022, 2024).

The trade-off between breadth and depth is arguably more important if consumers devote only little attention to a search problem and rather need to choose how to use a given amount of attention. In our main model, this is the case if δ is rather small. Supporting that this scenario is relevant, researchers (Alexandrov and Koulayev, 2018; Consumer Financial Protection Bureau, 2015; De Los Santos et al., 2012; Honka and Chintagunta, 2017; Woodward and Hall, 2012) find that the propensity of consumers to search drops off sharply after having considered only a few options, even though additional options are readily available and the option value of continued search is high.

In many of our applications, consumers may not only use their attention to process information, but also to choose how to trade-off different product attributes. For example, a consumer may see at a glance that a food item is high in carbs and low in fats, but they may still need to allocate attention to think about how to trade-off between these two attributes, and the price. Indeed, Fehr et al. (2022) and Shah et al. (2015) provide evidence that consumers need to focus their cognitive capacity to make trade-offs.

6.2 Evidence

The distraction effect helps connect evidence related to pricing, product design and advertisement. First, Dubois et al. (2018) find that exposure to advertisements allows firms to charge larger prices.[22] In line with classic views on persuasive advertisement (see Bagwell, 2007), exposure seems to shift the demand curve. But exposure also rotates the demand curve, suggesting—in line with our distraction effect— that consumers pay less attention to alternative offers. Second, Hortaçsu et al. (2017) study the Texan electricity market after liberalization and argue that—like in our model—brand preferences and consumer inertia are key industry features. In line with our results, they find that most entrants who charge lower prices than the previous incumbent offer only one plan with a single rate, suggesting they design relatively simple contracts with less match-value dispersion to facilitate comparison shopping. Third, in equilibrium, firms use niche designs to lower demand elasticities, which lowers price dispersion for large prices. This closely resembles pricing patterns of retailers of regular prices and sales (Eden, 2018; Eichenbaum et al., 2011; Nakamura and Steinsson, 2008, 2011; Pesendorfer, 2002), according to which regular prices have less price dispersion than sales prices. We offer a novel attention-based explanation for such pricing patterns according to which firms encourage price comparison especially when they charge low prices. In line with this mechanism, Pesendorfer (2002) emphasizes that price reductions are regularly advertised. Finally, suggesting that mass-market products have indeed more price dispersion, Eden (2018) find that products sold in more stores and with larger revenue have more price dispersion.

6.3 Firm Strategies and Attention

Our insights from Propositions 4 and 5 shed new light on how firm strategies affect consumer attention. We now discuss such strategies. Where appropriate, we highlight model extensions.

Excessive Information. To start, we consider applications where design stands for product information. Our results offer a novel channel through which firms disclose product information and thereby harm consumers. More-detailed product information help consumers make better choices about their match values. Fixing how consumers allocate attention, these information improve matches and benefit consumers. But by encouraging consumers to study and seek information for better matches, firms also distract consumers with limited attention from price comparison and increase the share of captive consumers. This way, firms who help consumers to find a better product match might even harm the consumers who seek this information.

Proposition 5 suggests that whether more information benefit or harm consumers depends on how abundant their attention is. If attention is abundant, more product

[22] They study the UK market for chips where manufacturers typically make many product varieties available. In line with our extension on brand proliferation that we discuss in Section 6.3, the advertisement ban makes it harder to emphasize taste-based features like the varieties of chips, putting prices more into focus.

information can benefit consumers. This reflects the argument by Nelson (1974) that advertising informs consumers about their match values with products and creates benefits to consumers. However, if attention is rather limited, more product information discourage comparison shopping, leading to larger prices and lower consumer surplus. From the point-of-view of consumers, firms provide excessive information.

Obfuscation. Because the distraction effect is stronger if consumer attention is scarcer, Proposition 5 also suggests that firms may want to congest consumer attention to make it scarce. Through this channel, our results have implications for how firms may present information. Indeed, in our setting firms may want to obfuscate information to make sure consumers need to use scarce attention to understand it. We explore this in detail in an extension to our baseline model in Appendix A.2. In this extension, firms choose in stage one also whether to make their design easily understandable or obfuscate it. If a firm's design is easily understandable, value shoppers initially assigned to this firm understand their match value without using any attention.[23] But if firms obfuscate designs, value shoppers have to use attention to study their match value just like in the baseline model. We find that firms who exploit the distraction effect in equilibrium combine large prices with *detailed but obfuscated information*. Intuitively, take a firm who wants to exploit the distraction effect and charges $(\overline{p}, \overline{s})$ in equilibrium. If this firm, when charging $(\overline{p}, \overline{s})$, would make information easily understandable, they would free-up attention that their customers could use to browse rivals, which could lower demand. Thus, while our results state that firms make excessive information available, they are also in line with the view that firms want to obfuscate information (Chioveanu and Zhou, 2013; Ellison and Wolitzky, 2012; Gu and Wenzel, 2014; Carlin, 2009).

Brand Proliferation. Finally, to capture attention, firms can make a more product varieties available. E.g. a phone or car may come in different colors, or food like chips may come in different flavors. Our results suggests that firms may make many such varieties available to encourage consumers to study to figure out which one they like best; by doing so, they discourage price comparison and relax competition. We study such attention-based *brand proliferation*—i.e. making excessive varieties available—in an extension in Web Appendix C.1. Each firm can choose how many product varieties it wants to make available. Akin to our baseline model, each variety has the same bimodal match-value distribution. Consumers now study a firm to learn which of its product varieties suits them best. As firms make more varieties available, consumers who study are more likely to find a good match, which encourages consumers to study product varieties rather than

[23]For example, in a laboratory experiment by Kaufmann et al. (2018), distracting consumers worsens choice quality about health insurance plans. But in line with our hypothesis that firms can make information easily understandable to free-up attention, personalized information about health insurance plans improves choice quality.

browsing prices of other suppliers. Thus, firms may use brand proliferation to distract consumers from price comparison and relax competition.

6.4 Policy Implications

We now discuss implications of our results for how interventions could promote or discourage competition.

Standardization of Product Features. Propositions 3 and 4 state that firms may offer niche product designs to distract consumers from price comparison. Thus, standardizing product features like safety features in cars, or technology standards on HDMI- or USB cables can encourage comparison shopping and thereby benefit consumers. Moreover, Proposition 5 suggests that standardization may be more pro-competitive in environments where consumer attention is scarce.

Product Information. Our results help understand which information-based interventions benefit consumers with limited attention. As we discussed in Section 6.1, more-dispersed match values capture that firms disclose more-precise information about products. We identify two channels through which information-based interventions encourage comparison shopping. First, Proposition 3, 4, and 5 suggest that coarser information, i.e. a lower $\overline{s}$ encourage comparison shopping, which can increase consumer surplus. Second, as we discussed in the previous subsection, firms who charge large prices want to obfuscate information to discourage price-comparison. Thus, making product information easily-available allows consumers to learn the match value of their initially-assigned firm and still have attention left to browse prices. A clear message emerges from these results: interventions that push for coarser and easily-available product information encourage comparison shopping and competition. Reversely, interventions that make more-detailed or more-precise product-information available can backfire, because they distract consumers from comparison shopping.

These predictions are in line with the aforementioned evidence that advertisement bans make consumers more price sensitive (see Dubois et al., 2018). We suggest an attention-based mechanism to explain this evidence: less exposure to ads distracts consumers less from price comparison. This evidence, however, is also in line with other explanations. For example, ads could make products appear more differentiated and make consumers less price sensitive even without affecting attention. But we now discuss evidence on product labels suggesting that attentional refocusing—and therefore our distraction effect—explains observations.

Product labels such as front-package food labels (FPFL) like the nutriscore in the EU or multi-traffic-light labels in the UK aggregate information on health of food, which nutri_dubois.jpg mtl_dubois.jpg

Figure 5: Nutriscore (left) and multi-traffic-light label (right). Source: Dubois et al. (2021) Figure 1.

makes them rather coarse pieces of information. Because FPFLs are printed on the front of a package, they also make information more-easily available.[24] Thus, our results predict that such labels redirect consumer attention towards product comparison.

Indeed, lab and field evidence shows that FPFLs encourage comparison shopping: consumers choose healthier (Barahona et al., 2021; Chantal et al., 2017; Crosetto et al., 2020; De Bauw et al., 2021; De Temmerman et al., 2021; Dubois et al., 2021; Egnell et al., 2019; Hagmann and Siegrist, 2020), and cheaper food (Barahona et al., 2021).[25]

Evidence shows that our mechanism—attentional refocusing—is a key reason for why FPFLs encourage comparison shopping. First, Crosetto et al. (2020) and Dubois et al. (2021) report that consumers refocus attention away from nutrient tables towards FPFLs. Second, lab-(Crosetto et al., 2020) and field-work (Dubois et al., 2021; Kiesel and Villas-Boas, 2013) compare coarser labels like the nutriscore and labels with more-precise information like the UK's multi-traffic-light label (see Figure 5). Both labels induce healthier choices than scenarios without labels. But, as we predict, the coarser nutriscores more effectively induce comparison shopping and healthier food-choices. Overall, this evidence underlines the relevance of our main mechanism: FPFLs induce consumers to redirect attention towards comparison shopping.

From a classic economic perspective without limited attention it might not be obvious why coarser and less-detailed information improve consumer choices. Our results, however, highlight a pro-competitive effect of nutriscores and complement the perspective that consumers benefit: coarser and easily-accessible information encourage consumers who care about match values—i.e. who care about a healthy diet—to do more comparison shopping. This may induce some mismatches, but also—in equilibrium—benefits consumers through more intense competition.

Our equilibrium predictions are also in line with anecdotal evidence on nutriscores. First, Propositions 4 suggests that firms who target a mass market disclose coarser information and therefore have larger incentives to adopt a nutriscore. Indeed, once several EU governments permitted the nutriscore on a voluntary basis, among the first to apply them were sellers that arguably target mass audiences, such as supermarket chains

[24] One might argue that FPFLs inform about a product's healthiness, which is a quality feature. But Pachali et al. (2023) show that brands that obtain a high-sugar warning label in Chile raise their prices, which could mean that some consumers have a higher willingness-to-pay for less-healthy high-sugar content. In any case, our model also captures vertical differentiation in the following sense: Consumers correctly predict expected quality μ, but some firms are above average and others below and consumers have to use attention to understand their precise quality level.

[25] See Ikonen et al. (2020) for a meta-study on multiple food labels.

for their own brands and large food producers like Danone and Iglo.[26] Second, in line with our prediction that more-precise information increase industry profits, the industry lobby opposed nutriscores by suggesting alternatives with more-detailed information (Julia et al., 2018a,b). Notably, Nestlé was crucially involved in this lobbying effort against nutriscores (Julia et al., 2018b). But—in line with our result that firms who target a mass market unilaterally prefer coarse information—Nestlé introduced nutriscores in Austria, Belgium, Germany, and France in 2020 even though they are voluntary.[27]

Our results suggest that compulsory nutriscores could further benefit consumers. Because nutriscores are voluntary in the EU, firms may strategically choose not to use them. Without nutriscore, consumers may use more attention to read nutrient tables or product reviews and do less comparison shopping. Thus, compulsory nutriscores would not just help consumers identify healthy food, but also encourage competition by pushing all sellers to compete more fiercely.

Remark: Product labels can also confuse consumers. Langer et al. (2007) show that a large number of eco-labels confuse consumers. Instead, we explore how credible labels and their degree of precision influence competition. Indeed, Langer et al. (2007) show that credible labels actually help consumers and they call for more regulation of labels. The evidence we discuss in this section on nutriscores, multi-traffic labels, and other regulated labels shows that they are rather credible.

7 Related Theoretical Literature

Our work connects to several literatures, but our main contribution is that we uncover the novel distraction effect, i.e. that firms use design to divert consumer attention away from comparison shopping, and its implications on welfare, product and information design.

Product differentiation and competition. A wide range of articles highlights how firms prefer more product differentiation to relax competition (Anderson and Renault, 2006; Armstrong and Zhou, 2022; Hefti et al., 2022; Johnson and Myatt, 2006). Most recently, Hefti et al. (2022) show that firms—to relax price competition—inform or confuse consumers about their preferences if that makes products appear more differentiated. Our article complements and goes significantly beyond these results. First, our

[26] In Belgium, nutriscores were recommended by the government in 2018, and applied by Aldi, Carrefour, Colruyt, and Delhaize on their own-brand products; see https://www.health.belgium.be/fr/les-marques-et-le-nutri-score-en-belgique-0. In France they were applied by Auchan, Carrefour, Casino, Intermarché, and Leclerc, for their own brands. https://www.foodwatch.org/fileadmin/-DE/Themen/Ampel/Dokumente/Engages_Nutri-Score_271020.pdf. In Germany, Danone and Iglo wanted to introduce the French nutriscores already before the government had a framework in place, see https://www.euractiv.com/section/agriculture-food/news/no-colour-coded-nutriscore-for-nestle-in-germany/. All accessed on 2. April 2024.

[27] On Nestlé introducing the nutriscore, see https://www.foodbev.com/news/nestle-to-introduce-nutri-score-nutrition-labelling-in-europe/, accessed on 2. April 2024.

mechanism is qualitatively different and relies on how consumers allocate their limited attention. This is why our mechanism can explain evidence that front-package-food labels encourage competition by redirecting consumer attention. Second, our mechanism has novel normative implications: in line with previous work, we show that reinforcing differentiation with abundant attention may harm or benefit consumers. But when consumer attention is sufficiently scarce, more differentiation reinforces the distraction effect and harms consumers.

Our results suggest that standardization reinforces competition. In classic models of product differentiation with full attention (e.g. Ronnen, 1991; Veall, 1985), standards work by affecting consumer preferences: standards make products less desirable for some consumers, but also make products more homogeneous and thereby encourage competition. Our distraction effect is a novel attention-based channel through which standards can benefit consumers. This perspective leads to novel insights and we show that standards are more pro-competitive in environments where consumer attention is limited.

Consumer search and limited attention. Ellison and Wolitzky (2012) show in a sequential search model with convex search costs that firms may raise search costs to discourage further search. This bears some resemblance to our distraction effect. In our setting, however, firms discourage price comparison using product design and information. Thus, we derive a rich set of novel predictions on how firms may use these features to discourage price comparison.

In a non-sequential search setting, some articles study competing firms that can affect consumers' consideration sets. Firms can use marketing messages (Eliaz and Spiegler, 2011a), or menus (Eliaz and Spiegler, 2011b) to attract attention. But firms do not divert attention away from products of rivals, so these articles do not feature the distraction effect that drives our main results.

Many existing search models based on Wolinsky (1986) and Anderson and Renault (1999) feature prices and match values, but existing models commonly assume that consumers who search a product learn both its price and match value.[28] Also existing work on competition with limited attention (e.g. Anderson and De Palma, 2012; Bordalo et al., 2016; Hefti, 2018; Hefti and Liu, 2020) mostly assumes consumers fully understand products they pay attention to. An exception is Heidhues et al. (2021), who investigate how consumers allocate attention between a product's basic- and secondary fees. We build on their approach and model limited attention as a trade-off between breadth and depths of search. In their setting, an individual firm has only a very limited influence on how consumers allocate attention and can use only its headline price to affect search directly. A firm in our setting can also use designs to influence dispersion of match values, which

[28] A recent exception is Petrikaitė (2022), where consumers observe prices but have to choose whether to pay a search cost to learn match values or not. But because consumers know all prices initially, they face no trade-off between browsing and studying.

allows us to discover our distraction effect and leads to rich novel insights about product and information design.

We contribute to work on **product design** based on Johnson and Myatt (2006). Closest to us, Bar-Isaac et al. (2012) investigate product design in a sequential search model. They find that high-quality firms charge higher prices and prefer less-dispersed match values to maximize demand from consumers who searched it. Our distraction effect makes qualitatively different predictions: our equilibrium features the opposite correlation between prices and dispersion.

We complement existing explanations for **information overload** when competing firms supply information, e.g. via advertisement. In Anderson and De Palma (2012), Hefti and Liu (2020), and Van Zandt (2004), information overload is the result of miscoordination between firms in the spirit of a common-pool resource: firms send ads to compete for the limited attention of consumers, leading to excessive advertisement. In our setting, individual firms deliberately overload consumers with product information to congest their limited attention and prevent them from comparison shopping.

Also Persson (2018) shows that a single firm may induce information overload: if a regulator forces a firm to disclose unfavorable product attributes, the firm may disclose irrelevant information to divert attention. This diversion tactic bears some relation to our distraction effect. But Persson (2018) focuses on information design and we complement her work by allowing firms to also set prices endogenously. This leads to qualitatively novel predictions for how a diversion tactic mitigates competition.

Obfuscation and Price Frames. We also complement existing work on price frames and obfuscation (e.g. Chioveanu and Zhou, 2013; Gu and Wenzel, 2014; Carlin, 2009; Piccione and Spiegler, 2012; Spiegler, 2014). Firms use price frames to influence the ability of consumers to compare prices of homogeneous products. Firms play mixed strategies and combine large prices with price frames that complicate price comparison. Our mixed strategies resemble this result but go significantly beyond it: First, a main insight in this literature is that interventions to facilitate price comparison can backfire. Intuitively, after such an intervention firms may focus on the segment of consumers that remains less competitive and charge larger prices. We contribute by identifying precisely which informational interventions benefit consumers. Second, existing work fixes consumer search behavior exogenously. We endogenize how consumers allocate their attention, which allows us to identify our novel distraction effect and its rich implications.

Strategic Inference from Obfuscation. Consumers who observe a firm's obfuscation strategy may infer something about the firm and adjust their attention accordingly (Martin, 2017; de Clippel and Rozen, 2022). Martin (2017) studies a monopoly seller who may obfuscate low quality, but buyers who observe the obfuscation strategy will use their limited attention to learn quality.[29] de Clippel and Rozen (2022) analyze a sender

[29] Martin (2016) provides lab evidence that buyers use attention strategically this way.

who may try to obfuscate information if they and the receiver have opposing interests. But the receiver adjusts their perception in response to obfuscation. They provide lab evidence in line with their predictions. According to these articles, a seller may choose not to use a nutriscrore label to obfuscate information on ingredients, and buyers may adjust their attention strategy accordingly. Our mechanism makes similar predictions but is qualitatively different and also complements these results. First, in our setting sellers have no private information that buyers could infer; instead they obfuscate to deplete cognitive resources of buyers. Second, we allow for multiple sellers, which allows us to study the anti-competitive implications of such obfuscation strategies.

8 Conclusion

We investigate how firms design products and product information to influence how consumers allocate their attention away from or towards product comparison. Most importantly, firms combine large prices with niche designs to distract consumers from price comparison.

We show that firms may want to make excessive product information available. However, our framework with limited attention does suggest some natural boundaries on the amount of information that a firm is willing to supply: firms can only distract consumers with information that consumers consider worth studying. Thus, if the amount of information is too excessive, or the consumers' cost of digesting this information becomes prohibitively large, firms would not want to make such information available. Along these lines, it becomes natural to interpret $\overline{s}$ as the maximum amount of information that a consumer is willing to digest.

Similarly, a larger amount of information could be harder for consumers to digest and require more attention capacity. This feature is missing from our model, where studying requires the same amount of attention for any level of information s. Nonetheless, we find our approach reasonable. First, whether less information requires less attention is also a strategic choice of firms. Indeed, Persson (2018) shows that firms can make somewhat useless information available to divert attention. This allows firms to raise the cost of processing information without changing informational content. That firms in our framework may want to do that is very much in line with the distraction effect and our extension on obfuscation. Second, in equilibrium, firms often induce studying with the maximum amount of dispersion $\overline{s}$, and otherwise choose sufficiently low dispersion to induce browsing. Thus, we intuit that our results are robust, also if studying designs $s < \overline{s}$ requires less attention.

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A Extensions

A.1 Full Attention

This section discusses a benchmark where consumers are not restricted by limited attention. More precisely, consider the following variant to our baseline model in Section 2. Bargain shoppers still consider all products as homogeneous with value v and observe all prices, and value shoppers observe all prices and match values.

Suppose consumers have no limited attention that they learn their match values and prices of both products in the market. For simplicity, we focus on the baseline model with binary match value distribution and restrict firms' product design $s \in [\underline{s}, \overline{s}]$ where $\underline{s} > \mu$. The following Proposition characterizes firms' equilibrium profit and shows that firms choose maximum dispersion with probability 1.

Proposition A.1. *In the unique symmetric equilibrium, firms' profit equals* $\frac{\alpha}{4}(\mu + \overline{s})$*. Firms choose* $\overline{s}$ *with probability* 1*. Value shoppers buy with probability 1 if and only if their match value with at least one of the firms is* $\mu + \overline{s}$*.*

Thus, unlike our baseline model, without the limited attention of consumers, firms have no incentive to adopt a mass market product design and will always choose maximum dispersion. Intuitively, firms do not have to incentivize studying, and an increase in $\overline{s}$ increases the consumption surplus and allows firms to charge a higher price. The following corollary shows that without the distraction effect, an increase in $\overline{s}$ increases both firms' profit and average consumer surplus.

Corollary A.1. *Firms' profit and average consumers' surplus increase in* $\overline{s}$*, i.e., informative advertisement without limited attention improves both firms' profit and average consumers' surplus. Value shoppers' surplus increases, but bargain shoppers' surplus (weakly) decreases in* $\overline{s}$*.*

Thus, without the limited attention and the distraction effect, the increase in price never outweighs the increase in match value benefited from informative advertisement, and consumers are, on average, better off. A similar conclusion also holds in the case of a persuasive advertisement, which induces an increase in μ.

Corollary A.2. *Firms' profit and average consumers' surplus increase in* μ*, i.e., persuasive advertisement without limited attention improves both profits and average consumers' surplus.*

A.2 Easily-Available or Obfuscated Information?

In this subsection, we show that while firms want to send more information to consumers to increase dispersion s, they might not want to make match value information readily

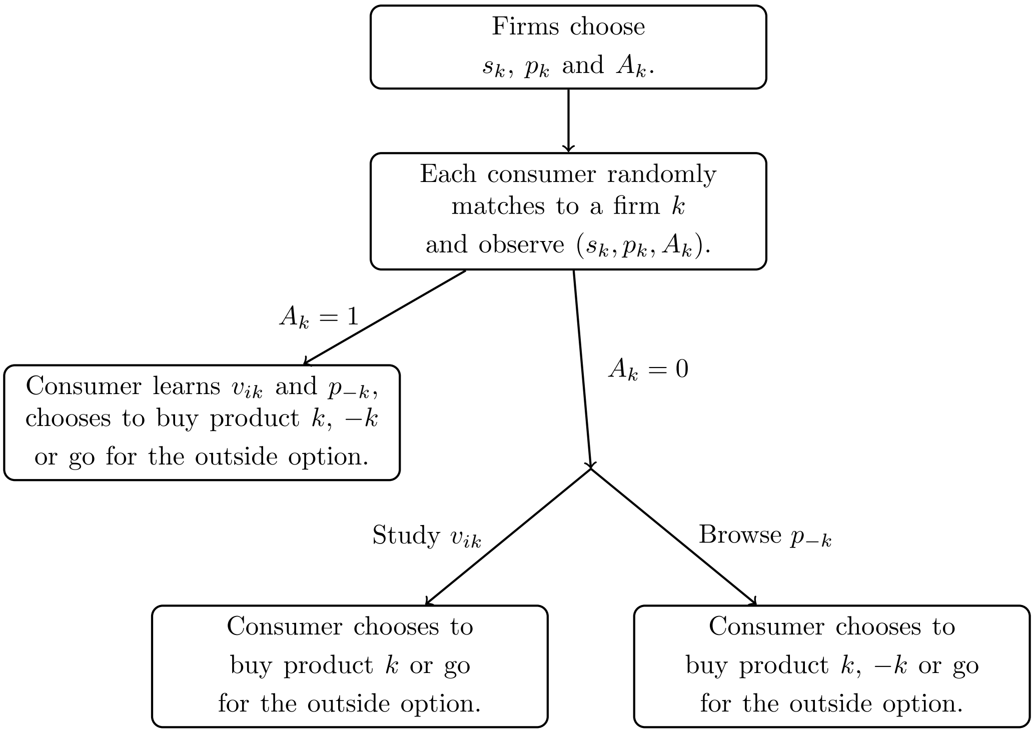

Figure 6: Time-line of the extended game

available. This reinforces our result that firms use information as a distraction tool to strengthen their monopoly power but not a tool to induce a better match, distinguishing our result and mechanism from classical models with horizontal differentiation.

To see this, consider an extension of the baseline model from Section 2 such that firms choose not only price p_k and design s_k, but also whether to make match value information readily available which we denote as A_k. If $A_k = 1$ firm k makes match value information easily available, meaning that consumers who start searching with firm k learn the price p_k *and* the match value v_{ik} without using any attention. Thus, when $A_k = 1$ value shoppers initially assigned to firm k know p_k and v_{ik}, and still have cognitive resources to browse the price of firm $-k$. If $A_k = 0$, consumers are subject to limited attention as in the baseline model where they decide to study (learn v_{ik}) or to browse (learn p_{-k}). The timeline is illustrated in Figure 6.

To simplify the analysis, we assume that $s \in \{0, \overline{s}\}$. This captures the result from Proposition 1 in the main text that firms choose extreme designs.

Proposition A.2. *There exists some threshold $\alpha_A < 1$ and $\overline{s}_A < \frac{4-3\alpha}{\alpha}\mu$ such that for $\alpha \geq \alpha_A$ and $\overline{s} \geq \overline{s}_A$, there exists an equilibrium where firms mix (p, s) as in the baseline model and choose $A_k = 0$. In addition, when $\overline{s} \in [\overline{s}_A, \frac{4-3\alpha}{\alpha}\mu)$, firms strictly prefer to obfuscate (set $A_k = 0$) when charging $\overline{p}$.*

The Proposition shows that when the distraction effect is strong enough, i.e., α and $\overline{s}$ are sufficiently large, firms benefit from the distraction effect in equilibrium, i.e., firms who charge $\overline{p}$, make detailed information available, but prefer to obfuscate this information.[30] The intuition is as follows. First, note that firms earn strictly less than the monopoly profit when $\overline{s} < \frac{4-3\alpha}{\alpha}\mu$. At $(\overline{p}, \overline{s})$, firms strictly benefit from diverting value shoppers' attention to avoid price competition: if, in contrast, firms do not obfuscate, value shoppers can spend their attention to browse for a lower price such that firms lose demand.

B Proofs

B.1 Proof of Lemma 1

Proof. Without loss of generality, we fix $k = 1$. We first consider $s_1 \geq \mu$, such that $p_1 \geq 0 \geq \mu - s_1$. Value shoppers' expected utility of studying equals:

$$U_{\text{study}} = \frac{1}{2}(\mu + s_1 - p_1),$$

and their expected utility of browsing equals:

$$U_{\text{browse}} = \begin{cases} \mu - (1 - G_2(p_1))p_1 - G_2(p_1)E_{G_2}(p_2 \mid p_2 \leq p_1) & \text{if } p_1 \leq \mu; \\ G_2(\mu)\left(\mu - E_{G_2}(p_2 \mid p_2 \leq \mu)\right) & \text{if } p_1 > \mu. \end{cases}$$

The expected utility of studying is smaller than that of browsing if and only if

$$\begin{cases} \frac{1}{2}(\mu + s_1 - p_1) - [\mu - (1 - G_2(p_1))p_1 - G_2(p_1)E_{G_2}(p_2 \mid p_2 \leq p_1)] < 0 & \text{if } p_1 \leq \mu; \\ \frac{1}{2}(\mu + s_1 - p_1) - G_2(\mu)\left(\mu - E_{G_2}(p_2 \mid p_2 \leq \mu)\right) < 0 & \text{if } p_1 > \mu, \end{cases}$$

or equivalently

$$\begin{cases} \frac{1}{2}(p_1 + s_1 - \mu) - G_2(p_1)\left[p_1 - E_{G_2}(p_2 \mid p_2 \leq p_1)\right] < 0 & \text{if } p_1 \leq \mu; \\ \frac{1}{2}(\mu + s_1 - p_1) - G_2(\mu)\left(\mu - E_{G_2}(p_2 \mid p_2 \leq \mu)\right) < 0 & \text{if } p_1 > \mu, \end{cases} \tag{B.1}$$

in which the inequality is clearly satisfied when $p_1 = \mu + s_1$ and violated when $p_1 = 0$. Moreover, if $p_1 > \mu$, the first derivative w.r.t. p_1 equals to $\frac{\partial\left(U_{\text{study}} - U_{\text{browse}}\right)}{\partial p_1} = -\frac{1}{2} < 0$. If $p_1 \leq \mu$, we first prove that the inequality is continuous in p_1. Because browsing value shoppers are indifferent between buying from firm 1 or firm 2 when $p_1 = p_2$, we can

[30] When α and $\overline{s}$ is large enough, it is not profitable for firms to deviate to a price higher than $\overline{p}$, not obfuscate, and therefore engage in price competition with their rivals. Thus, the profit driven by the distraction effect is larger than that driven solely by the classical horizontal differentiation.

rewrite U_{browse} as follows:

$$\begin{aligned}U_{\text{browse}} =&\mu - (1 - G_2(p_1))p_1 - G_2(p_1)E_{G_2}(p_2 \mid p_2 \leq p_1)\\ =&\mu - (1 - \Pr_{G_2}(p_2 < p_1))p_1 - \Pr_{G_2}(p_2 < p_1)E_{G_2}(p_2 \mid p_2 < p_1)\end{aligned}$$

where the first equality breaks tie in favor of firm 1 and the second equality breaks tie in favor of firm 2. Thus, the Inequality (B.1) can be rewritten as:

$$\begin{aligned}&\frac{1}{2}(p_1 + s_1 - \mu) - G_2(p_1)\left[p_1 - E_{G_2}(p_2 \mid p_2 \leq p_1)\right]\\ =&\frac{1}{2}(p_1 + s_1 - \mu) - \Pr_{G_2}(p_2 < p_1)\left[p_1 - E_{G_2}(p_2 \mid p_2 < p_1)\right]\\ <&0.\end{aligned}$$

As $G_2(p_1)$ and $E_{G_2}(p_2 \mid p_2 \leq p_1)$ are right continuous, and $\Pr_{G_2}(p_2 < p_1)$ and $E_{G_2}(p_2 \mid p_2 < p_1)$ are left continuous, the inequality is left and right continuous, and is thus continuous. The LH derivative of the inequality is equal to

$$\lim_{p \to p_1^-} \frac{\partial\left(U_{\text{study}} - U_{\text{browse}}\right)}{\partial p} = \frac{1}{2} - \Pr_{G_2}(p_2 < p_1)$$

which, combined with continuity and the fact that $\Pr_{G_2}(p_2 < p_1)$ is (weakly) increasing in p_1, implies the inequality is single-peaked and decreasing when p_1 is big enough. Thus, there exists a threshold such that the inequality is satisfied, i.e., browsing is better than studying if and only if p_1 is bigger than the threshold.

Now consider $s_1 < \mu$. We first show that $U_{\text{study}} - U_{\text{browse}} < 0$ for all $p_1 \leq \mu - s_1$. If the value shopper studies match values, they buy no matter if their match value is high or low. Her expected utility equals $\mu - p_1$. On the other hand, if they choose to browse, they will buy from firm 2 if $p_2 < p_1$. Her expected utility equals

$$U_{\text{browse}} = \mu - (1 - G_2(p_1))p_1 - G_2(p_1)E_{G_2}(p_2 \mid p_2 < p_1)$$

which is clearly strictly bigger than $U_{\text{study}} = \mu - p_1$. On the other hand, when $p_1 > \mu - s_1$, a similar analysis as in the case $s_1 \geq \mu$ concludes that $U_{\text{study}} - U_{\text{browse}}$ is single peaked and decreasing when p_1 is big enough. As $U_{\text{study}} - U_{\text{browse}}$ is continuous at $p_1 = \mu - s_1$, depending on G_2 and s_1, either the value shopper browses for all p_1, for example when $s_1 = 0$; or they browse if and only if $p_1 < \tilde{p}'$ or $p_1 > \tilde{p}$, for example when $G_2(p) \approx 0$ for all $p \leq \mu - s_1$.

Finally, note that while U_{browse} is constant in s_1, U_{study} is constant in s_1 if $s_1 < \mu - p_1$ and strictly increasing in s_1 otherwise. Thus, a larger s_1 increases the value shopper's incentive to study match values.

□

B.2 Proof of Proposition 1

Proof. As $1 - F_s(v)$ is continuous (constant and equal to $\frac{1}{2}$) for $v \in (\mu - s, \mu + s)$, we can apply the proof of Proposition 4 for the special case $\delta = 0$. Thus, there are no gaps and mass points for prices in $[\underline{p}, \mu]$, $s(p) = \overline{s}$ at $p = \overline{p}$, and bargain shoppers browse prices with probability one. Moreover, the equilibrium prices are distributed either on $\{p^M\}$ where $p^M = \arg\max_{p \leq \mu + \overline{s}} \frac{\alpha}{4} p = \mu + \overline{s}$, on $[\underline{p}, \mu] \cup \{\overline{p}\}$ where $\overline{p} \in (\mu, \mu + \overline{s})$, or on $[\underline{p}, \overline{p}]$ where $\overline{p} \leq \mu$.

First, suppose in contrast that there exists an equilibrium where equilibrium prices are deterministic and equal to $\mu + \overline{s}$. Value shoppers thus study, and bargain shoppers browse. Firms' profit equals to $\frac{\alpha}{4}(\mu + \overline{s})$. Now suppose a firm deviates to charging price μ and choosing design $s = 0$. It sells to all bargain shoppers and its own value shoppers, with profit equals:

$$\left[\frac{\alpha}{2} + (1 - \alpha)\right] \mu$$

which is strictly larger than $\frac{\alpha}{4}(\mu + \overline{s})$ as $\overline{s} < \mu \frac{(4-3\alpha)}{\alpha}$. Thus we have a contradiction.

Second, we prove that when $\overline{s} = \mu(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right]$, we have $\frac{\alpha}{4}\overline{p} = \left(\frac{\alpha}{4} + (1-\alpha)\frac{1}{2}\right)\mu$. To prove the equality, we suppose $\frac{\alpha}{4}\overline{p} = \left(\frac{\alpha}{4} + (1-\alpha)\frac{1}{2}\right)\mu$ in equilibrium, and verify that $U_{\text{study}} = U_{\text{browse}}$ at $\overline{p}$ when $\overline{s} = \mu(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right]$. First, $\overline{p} > \mu$, and as firms must earn the same profits at $p = \overline{p}$ and $p = \mu$, $\frac{\alpha}{4}\overline{p} = \left(\frac{\alpha}{4} + (1-\alpha)\frac{1}{2}\right)\mu$ implies that $G(\mu) = \frac{1}{2}$. $G(\mu) = \frac{1}{2}$ in turn implies that for all $p < \mu$, demand from browsing value shoppers, $G(p)$, is higher than studying value shoppers, $\frac{1}{2}$, and thus firms induce browsing. Second, because firms must earn the same profits at $\overline{p}$ and for all $p \leq \mu$, combined with continuity at $p = \mu$, we must have

$$\left[\left(\frac{\alpha}{2} + 1 - \alpha\right)(1 - G(p)) + \frac{\alpha}{2}\left(\frac{1}{2} - G(p)\right)\right] p = \frac{\alpha}{4}\overline{p} \quad \text{for all } p \leq \mu.$$

The right-hand side are profits at $\overline{p}$, where firms only sell to initially-assigned value shoppers who draw a good match. The left-hand side are profits for $p \leq \mu$. The first term in squared brackets captures that the firm sells to its initially-assigned value shoppers, who browse for such prices, and bargain shoppers if it is cheaper than the rival. The second term captures that the firm also sells to consumers initially-assigned to the rival who browse and find a cheaper price. Using the equality, $1 - G(p) = \frac{\alpha}{4}\frac{\overline{p}+p}{p}$ and $g(p) = \frac{\alpha\overline{p}}{4p^2}$

for $p \leq \mu$. Combined with $G(\mu) = \frac{1}{2}$, U_{browse} at $\overline{p}$ follows:

$$\begin{aligned} U_{\text{browse}} &= G(\mu)\mu - \int_{\underline{p}}^{\mu} pg(p)\, dp \\ &= \frac{1}{2}\mu - \int_{\underline{p}}^{\mu} \frac{\alpha}{4}\frac{\overline{p}}{p}\, dp \\ &= \frac{1}{2}\mu - \frac{\alpha\overline{p}}{4}\log\left(\frac{\mu}{\underline{p}}\right) \\ &= \frac{1}{2}\mu - \frac{\alpha\overline{p}}{4}\left(\log(\frac{\mu}{\overline{p}}\frac{4-\alpha}{\alpha})\right). \end{aligned}$$

Browsing shopping buys if and only if they find a price smaller than μ, which leads to the first equality. The second equality uses $g(p) = \frac{\alpha\overline{p}}{4p^2}$, and the last equality uses the fact that firms' profit at $\overline{p}$ and $\underline{p}$ are the same in equilibrium, i.e., $\frac{\alpha}{4}\overline{p} = \left[\frac{\alpha}{2} + 1 - \alpha + \frac{\alpha}{4}\right]\underline{p}$.[31] Next, as $1 - G(\mu) = \frac{1}{2}$, using $1 - G(p) = \frac{\alpha}{4}\frac{\overline{p}+p}{p}$, $\overline{p} = \frac{2-\alpha}{\alpha}\mu$. Lastly, $U_{\text{study}} = U_{\text{browse}}$ if and only if:

$$\begin{aligned} \frac{1}{2}(\mu + \overline{s} - \overline{p}) &= \frac{1}{2}\mu - \frac{\alpha\overline{p}}{4}\left(\log(\frac{\mu}{\overline{p}}\frac{4-\alpha}{\alpha})\right) \\ \Leftrightarrow \quad \frac{1}{2}(\mu + \overline{s} - \frac{2-\alpha}{\alpha}\mu) &= \frac{1}{2}\mu - \frac{(2-\alpha)\mu}{4}\left(\log(\frac{4-\alpha}{2-\alpha})\right) \\ \Leftrightarrow \quad \overline{s} &= \mu(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right]. \end{aligned}$$

The second equality uses $\overline{p} = \frac{2-\alpha}{\alpha}\mu$, and by rearranging the terms, we get the third equality. Therefore, we verify that $U_{\text{study}} = U_{\text{browse}}$ when $\overline{s} = \mu(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right]$, and $\frac{\alpha}{4}\overline{p} = \left(\frac{\alpha}{4} + (1-\alpha)\frac{1}{2}\right)\mu$ in equilibrium.

Now, as the proof of (point 10 of) Proposition 4 shows that $\overline{p}$ increases in $\overline{s}$, when $\overline{s} > \mu(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right]$, $\frac{\alpha}{4}\overline{p} > \left(\frac{\alpha}{4} + (1-\alpha)\frac{1}{2}\right)\mu$. It implies that first, $\overline{p} > \mu$. Second, because in equilibrium, firms must earn the same profits at $\overline{p}$ and μ, i.e.,

$$\frac{\alpha}{4}\overline{p} = \left(\frac{\alpha}{2}\max\left\{\frac{1}{2}, 1 - G(\mu)\right\} + (1-\alpha)(1 - G(\mu))\right)\mu$$

where the first term in the big bracket is the profit of selling to studying or browsing value shoppers and the second term is the profit selling to browsing bargain shoppers. As $\frac{\alpha}{4}\overline{p}$ is strictly larger than $\left(\frac{\alpha}{4} + (1-\alpha)\frac{1}{2}\right)\mu$, we must have $1 - G(\mu) > \frac{1}{2}$. It thus implies that the demand of browsing value shopper $(1 - G(\mu))$ is larger than that of studying value shoppers $\frac{1}{2}$, and firms must pick high enough s, e.g., $\overline{s}$, to induce browsing at μ. The result follows. □

[31] At $\underline{p}$, firm sells to its own value shoppers, all bargain shoppers, and the browsing value shoppers matched to its rival.

B.3 Proof of Proposition 2

Proof. Following (point 10 of) Proposition 4, $\overline{p}$ increases in $\overline{s}$. As each firm earns $\frac{\alpha}{4}\overline{p}$, their profits increase in $\overline{s}$. As $1-G(p)=\frac{\alpha}{4}\frac{\overline{p}+p}{p}$ for all $p \leq \mu$ and the mass point at $\overline{p}$ has probability mass $1-G(\mu)=\frac{\alpha}{4}\frac{\overline{p}+\mu}{\mu}$, equilibrium prices increase in the sense of F.O.S.D.. Value shoppers browse price with probability $G(\mu)$ in equilibrium, which decreases in $\overline{p}$ and thus decreases in $\overline{s}$. Next, when value shoppers study, they are indifferent between studying and browsing. Thus their surplus is the same as bargain shoppers'. Lastly, as prices increase in the sense of F.O.S.D., both bargain shoppers' and value shoppers' surplus decreases. □

B.4 Proof of Lemma 2

Proof. We first prove that an increase in s_k induces value shoppers to study firm k.

$$U^k_{\text{study}} = \int_{\delta V+p_k}^{\overline{v}} (v-p_k)\,dF_{s_k}(v) + F_{s_k}(\delta V+p_k)\delta V;$$

$$U^{k'}_{\text{study}} = \int_{\delta V+p_{k'}}^{\overline{v}} (v-p_{k'})\,dF_{s_{k'}}(v) + F_{s_{k'}}(\delta V+p_{k'})\delta V;$$

$$U_{\text{browse}} = \begin{cases} \int^{p_k}(\mu-p)\,dG(p) + [1-G(p_k)](\mu-p_k) & \text{if } \mu-p_k \geq \delta V; \\ \int^{\mu-\delta V}(\mu-p)\,dG(p) + [1-G(\mu-\delta V)]\delta V & \text{if } \mu-p_k < \delta V \end{cases}$$

for some k' in the value shopper's consideration set that he has not yet studied. For U^k_{study}, note that the consumer who studies firm k purchases if $v-p_k \geq \delta V$, i.e., if the consumption benefit of purchasing with match value v is above the continuation value, and continues to search for another period otherwise. For U_{browse}, note that the consumer prefers buying from some firm l over searching on if $\mu - p_l \geq \delta V$, and prefers searching on over buying from l otherwise. We have

$$\begin{aligned}
\frac{\partial(U^k_{\text{study}}-U_{\text{browse}})}{\partial s_k} &= \frac{\partial(U^k_{\text{study}}-U^{k'}_{\text{study}})}{\partial s_k} \\
&= \frac{\partial \int_{\delta V+p_k}^{\overline{v}}(v-p_k)\,dF_{s_k}(v)}{\partial s_k} + \frac{\partial F_{s_k}(\delta V+p_k)}{\partial s_k}\delta V \\
&= (v-p_k)\frac{\partial F_{s_k}(v)}{\partial s_k}\Big|_{\delta V+p_k}^{\overline{v}} - \int_{\delta V+p_k}^{\overline{v}} \frac{\partial F_{s_k}(v)}{\partial s_k}\,dv + \frac{\partial F_{s_k}(\delta V+p_k)}{\partial s_k}\delta V \\
&= -\int_{\delta V+p_k}^{\overline{v}} \frac{\partial F_{s_k}(v)}{\partial s_k}\,dv
\end{aligned}$$

The first line is implied by the fact that U_{browse} and $U^{k'}_{\text{study}}$ is invariant in s_k. The second line uses the formula of U^k_{study}. The third line uses integration by parts, and the forth line uses the fact $F_{s_k}(\overline{v})=1$ for all $s_k<\overline{s}$ and thus $\frac{\partial F_{s_k}(\overline{v})}{\partial s_k}=0$. For $v<\mu$, $\frac{\partial F_{s_k}(v)}{\partial s_k}>0$.

Moreover, using integration by parts, the assumption of constant mean implies that

$$\frac{\partial E_{s_k}(v)}{\partial s_k} = -\int_{\underline{v}}^{\overline{v}} \frac{\partial F_{s_k}(v)}{\partial s_k}\, dv = 0.$$

Both combined imply that $-\int_{\delta V+p_k}^{\overline{v}} \frac{\partial F_{s_k}(v)}{\partial s_1}\, dv > 0$, and a larger s_k incentivizes studying.

To prove that value shoppers browse for sufficiently large p_k. Note that when $p_k \geq \overline{v} - \delta V$, value shoppers do not buy only if the match value equals $\overline{v}$, and the utility of studying equals to δV. In contrast, by browsing, value shoppers could find prices lower than $\mu - \delta V$, and thus the utility of browsing is strictly larger than δV. We conclude that value shoppers browse for sufficiently large p_k. □

B.5 Proof of Proposition 3 and 4

Proof. We divide the proof into multiple statements. We first prove Proposition 3 with the first 7 statements, and afterwards impose Assumption 1 and proceed to prove Proposition 4.

Denote G as the equilibrium cumulative price distribution, $\overline{p}$ and $\underline{p}$ as the supremum and infimum of the support of G.

1. In each period t, if value shoppers do not study firm k in their consideration set, they do not study firm k in all subsequent periods; if value shoppers browse in period t, they buy in period t and do not search on. We prove the statement by induction. First, in period 1, say a value shopper is matched with firm k, and decides to browse. Suppose, in contrast, they do not buy in period 1 from any firm with some strictly positive probability. It implies that the value shopper does not buy from firm k, and thus $\mu - p_k < \delta V$ or equivalently $p_k > \mu - \delta V$. In the following, we prove that firm k has a strictly profitable deviation when $\delta = 0$, and hence, by continuity, δ close to 0. For $p_k > \mu - \delta V$, bargain shoppers will not buy from firm k, and value shoppers only buy from firm k in period $t > 1$. When $\delta \to 0$, firm k's profit goes to 0 when it charges $p_k > \mu - \delta V$, as all consumers browse and do not purchase for $p \geq \mu + \delta V$. Thus, in both cases, firms must zero profits. But by Lemma 2, firm k can instead charge a small enough $p_k = \epsilon_2$ together with $s_k = \overline{s}$ to induce value shoppers matched with firm k study match values for any G and V. And those value shoppers buy from firm k if they find that their match value is greater than $\delta V + \epsilon_2$. And since for $\delta < 1$ and a sufficiently small $\epsilon_2 > 0$ we have $V + \epsilon_2 \leq \delta\overline{v} + \epsilon_2 < \overline{v}$, this deviation attracts strictly-positive demand from initially-assigned value shoppers of firm k. Thus firm k can deviate to earn strictly larger profit, and we have a contradiction. We conclude that value shoppers who browse in period t must buy in period t with probability one.

This result implies directly that in period 1, if value shoppers do not study firm k

in their consideration set, they browse and purchase in period 1. Thus, they also do not study firm k in all subsequent periods (because if they have arrived in subsequent periods, they must have studied firm k and found a bad match).

Now suppose the statement holds in all periods $t = 2, \cdots, T$. At the beginning of period $T+1$, the value shoppers' consideration set only contains firms that they previously studied and with match values minus prices strictly lower than δV. Their search decisions are thus equivalent to that in period 1, i.e., if they browse and do not study a firm k' that they are matched in period $T+1$, they buy in period $T+1$ with probability one and do not search on.

As a result, in each period t, value shoppers' search decision depends on the product characteristics of the firm they are matched with in period t, but not the firms they are previously matched with. It implies that given V, the equilibrium is equivalent to that of a one-period game with an outside option equal to δV.

In the following, points 2 to 11 characterize firms' and consumers' equilibrium strategies given a continuation payoff V and the long-run proportion of value-shoppers denoted by $\tilde{\alpha}$. Point 12 shows that when δ is small enough, there exists a unique equilibrium continuation payoff V, and a unique equilibrium long-run proportion of value-shoppers $\tilde{\alpha}$.

2. Value shoppers study match value with strictly positive probability in each period. Suppose not, then all consumers must browse prices in equilibrium. Firms are effectively perfect substitutes and engage in Bertrand competition. Firms then make 0 profit. However, we have already shown in point 1 that firms can secure a strictly positive profit, and we have a contradiction.

3. Both firms make strictly positive profits. Firms must put no probability mass on $p > \overline{v}$. As by point 1 firms can secure strictly positive profit for all G, they must make strictly positive profit in equilibrium. Therefore, firms must put no probability mass on $p > \overline{v}$ as otherwise they make 0 profit.

4. Given V, the search decision of a value shopper initially assigned to firm k depends on the distribution of p_{-k}, but not on s_{-k}. Suppose a value shopper is matched to firm k, the statement follows because first, U_{browse} and U_{study} (see proof of Lemma 2 for formal definitions) do not depend on s_{-k}, and second, by point 1 value shoppers do not study firms that they were matched with in previous periods.

5. If G puts strictly positive mass on prices strictly above $\mu - \delta V$, we must have a mass point at $\overline{p}$ and no mass in $(\mu - \delta V, \overline{p})$. Moreover, $\overline{p} \leq \arg\max_p p(1 -$

$F_{\overline{s}}(\delta V + p))$. First note that firms earn positive profit for $p > \mu - \delta V$ if and only if value shoppers study at p, with demand $1 - \lim_{p' \to p^-} F_s(\delta V + p')$. Next, by Lemma 2 and the fact that $(1 - F_s(\delta V + p'))$ increases in s for all $p' > \mu - \delta V$, firms that charge $p > \mu - \delta V$ choose $\bar{s}$ in equilibrium. Next, by the weak log-concavity of $1 - F_{\overline{s}}(\delta V + p)$ and that there exists a unique monopoly price with $F_{\overline{s}}$, since only studying consumers purchase for prices $p > \mu - \delta V$, and since firms must earn the same expected profits for all prices in the support of their price distributions, firms must put a mass point at some $\overline{p}$ and no probability mass in $(\mu - \delta V, \overline{p})$. Now suppose $\overline{p} > \arg\max_p p(1 - F_{\overline{s}}(\delta V + p))$ and consider a deviation where firm 1 decreases slightly the price and fixes design at $\overline{s}$. Because firms have no probability mass in $(\mu - \delta V, \overline{p})$, we have

$$\frac{\partial U_{\text{study}} - U_{\text{browse}}}{\partial p} = \frac{\partial U_{\text{study}}}{\partial p} < 0,$$

and thus value shoppers still prefer to study. By the assumption of weak log-concavity of $1 - F_{\overline{s}}$ and that there exists an unique monopoly price with $F_{\overline{s}}$, the deviation is strictly profitable. The result follows.

6. When G puts probability 1 at some $p > \mu - \delta V$, $p = p^M =: \arg\max_p p(1 - F_{\overline{s}}(\delta V + p))$. Firms choose $\overline{s}$ with probability 1. Value shoppers study and bargain shoppers browse. If firms put probability 1 at some $p \in (\mu - \delta V, \arg\max_p p(1 - F_{\overline{s}}(\delta V + p)))$, $U_{\text{study}} > U_{\text{browse}} = \delta V$ and thus value shoppers strictly prefer to study. On the other hand, bargain shoppers will not buy. Firms can increase their price slightly, and by continuity, value shoppers still strictly prefer to study. By the assumption of weak log-concavity of $1 - F_{\overline{s}}$ and a unique monopoly price with $F_{\overline{s}}$, the deviation is strictly profitable.

7. When G puts a mass point of probability $\lambda < 1$ at $p > \mu - \delta V$, G must put no mass points nor gaps in $[\underline{p}, \mu - \delta V]$. Bargain shoppers browse prices with probability 1. Firm choose $s > 0$ such that value shoppers study at $\overline{p}$. If $\overline{p} > \mu - \delta V$, firms choose $\overline{s}$ at $\overline{p}$. We first prove there are no mass points for all $p \leq \mu - \delta V$. Suppose, to the contrary, there is a mass point at some p. If value shoppers are not indifferent between studying and browsing, then undercutting and keeping the same s would not affect the decisions of value shoppers. It yields a jump in demand from browsing consumers but only a marginal change in profits from studying consumers. Now, suppose value shoppers are indifferent between studying and browsing (and choose to study by our tie-breaking assumption). Denote $s(p)$ as the dispersion strategy at p. Next, as firms could have induced browsing by choosing $s = 0$, it must not be profitable for firms to undercut and choose $s = 0$, i.e., it is necessary that

$$1 - F_{s(p)}(\delta V + p') > 1 - \lim_{p' \to p^-} G(p').$$

Otherwise, by undercutting and choosing $s = 0$, firms' demand from previously-studying value shoppers changes only marginally and demand from previously-browsing value and bargain shoppers jumps. On the other hand, first, if $p = \underline{p}$, undercutting and choose $s = 0$ is strictly profitable as firms earn a jump in demand from browsing shoppers and a weakly increase in demand from studying consumers. Second, if $p > \underline{p}$, as $G(p) > 0$ and $G(\mu - \delta V)$, value shoppers are indifferent between studying and browsing only if $\delta V + p$ is not at the supremum nor infimum of the support of F. By continuity of F within its support, the marginal change of incentive to study instead of browse with respect to price follows:

$$\lim_{p' \to p^-} \frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial p'} = 1 - \lim_{p' \to p^-} G(p') - (1 - F_{s(p)}(\delta V + p')) \tag{B.2}$$

which is strictly smaller than 0 as argued above. Thus, by undercutting and choosing the same s, value shoppers strictly prefer to study. As undercutting and choosing the same s induces a jump in demand from browsing consumers but a negligible change in the profit from studying consumers, it induces a jump in profit. Thus, there does not exist a mass point under $\mu - \delta V$. As there is no mass point, bargain shoppers strictly prefer to browse and browse with probability 1.

Next, if $\overline{p} \geq \mu - \delta V$, by the same argument as in point 6, firms choose $\overline{s}$ at $\overline{p}$. Second, when $\overline{p} < \mu - \delta V$, because there is no mass point, value shoppers must study at $(\overline{p} - \epsilon, \overline{p})$ for some small ϵ as otherwise firms earn 0 profit. As $G(\overline{p}) = 1$, firms must choose $s > 0$ at $\overline{p}$ to induce studying.

Point 1 to 7 prove Proposition 3. We now impose Assumption 1 with $\xi \to 0$, and proceed to prove Proposition 4.

7 (cont.). When G puts a mass point of probability $\lambda < 1$ at $p > \mu - \delta V$, G must put no gaps in $[\underline{p}, \mu - \delta V]$. Firms choose $\overline{s}$, and $U_{\textbf{study}} = U_{\textbf{browse}}$ at $\overline{p}$. First, suppose towards a contradiction that there exists a gap in (p, p') where $p > \underline{p}$ and $p' \leq \mu - \delta V$ such that $G(p) = G(p')$. Suppose without loss of generality that there are no gaps in $(p - \epsilon', p)$ for some small ϵ'. First, consider the case that there exists some small $\epsilon' > \epsilon > 0$ where value shoppers browse for all prices in $(p - \epsilon, p)$. For small enough $\epsilon_2 > 0$, deviating to price $p' - \epsilon_2$ and $s = 0$ yields a jump in profit margin but induces no change in demand compared to prices $p - \epsilon_2$. Thus we have a contradiction.

Now consider the case that there exists some small $\epsilon' > \epsilon > 0$ where value shoppers study for all prices $p'' \in (p-\epsilon, p)$. Denote $s_{p''}$ as the solution of $U_{\text{study}}(s, p'') = U_{\text{browse}}(s, p'')$, firms must choose $s = s_{p''}$ for prices $p'' \in (p-\epsilon, p)$ as otherwise they could deviate to a smaller s which induce a higher demand (as $F_s(\delta V + p)$ increases in s for $p < \mu - \delta V$) while still inducing studying. We distinguish two cases. Case 1: $s < \overline{s}$ at p; Case 2: $s = \overline{s}$ at p. First, suppose $s < \overline{s}$ at p, firms can therefore increase s to induce studying at some $p+\epsilon_2$ for some small enough ϵ_2. When $\xi \to 0$, the change of the demand of value shoppers is negligible, but firms earn a higher margin from both studying and browsing consumers. Thus we have a contradiction.

Second, suppose $s = \overline{s}$ at p. Note that first $\delta V + p > 0 > \mu - \overline{s}$, and second $\delta V + p < \mu + \overline{s}$ as otherwise value shoppers do not buy from the firm and strictly prefer to browse. $\delta V + p$ is thus within the support of $F_{\overline{s}}$ and by continuity we have:

$$\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial p} = (1 - G(p)) - (1 - F_s(\delta V + p)).$$

First, as firms induce studying at p, $1 - F_{\overline{s}}(\delta V + p) \geq 1 - G(p)$. We could rule out $1 - F_{\overline{s}}(\delta V + p) = 1 - G(p)$ as otherwise firms have a strictly profitable deviation of charge $p + \epsilon_2$ and choose $s = 0$. When $\xi \to 0$, it also implies that, $1 - F_{\overline{s}}(\delta V + \tilde{p}) > 1 - G(\tilde{p})$ for prices $\tilde{p}$ strictly bigger than p but smaller than $\mu + \overline{s}$, because $F_{\overline{s}}(\delta V + \tilde{p}) \to F_{\overline{s}}(\delta V + p)$ and $G(\tilde{p}) \geq G(p)$. Second, as argued above, $U_{\text{study}} = U_{\text{browse}}$ at p as otherwise firms can deviate to a smaller s while induce studying and earn a higher profit. Combining the two observations implies that $U_{\text{study}} < U_{\text{browse}}$ for $\overline{s}$ and all prices larger than p. But it implies that at prices close to $\overline{p}$, firms cannot induce studying and earn 0 profit. Thus we have a contradiction.

Next, we prove firms choose $\overline{s}$ at $\overline{p}$. Point 7 (before we impose Assumption 1) proves that firms choose $\overline{s}$ at $\overline{p}$ when $\overline{p} > \mu - \delta V$. It remains to show that firms choose $\overline{s}$ at $\overline{p}$ when $\overline{p} \leq \mu - \delta V$. Suppose firms choose some $s < \overline{s}$ at $\overline{p}$. As argued above, firms can increase s to induce studying at some $\overline{p} + \epsilon_2$ for small enough ϵ_2. When $\xi \to 0$, the change of the demand of value shoppers is negligible but firms earn a higher margin from both studying and browsing consumers. Thus we have a contradiction.

Lastly, if $U_{\text{study}} > U_{\text{browse}}$ at $\overline{p}$, firms can increase price beyond $\overline{p}$ while still induce value shoppers to study. When $\xi \to 0$, the change of the demand from studying value shoppers is negligible and the deviation increases firms' margin. We have a contradiction.

8. When G puts a mass point of probability $\lambda < 1$ at $p > \mu - \delta V$, there exists some $\hat{p} \in (\underline{p}, \mu - \delta V]$ such that value shoppers browse if and only if $p < \hat{p}$. For $p \in (\hat{p}, \mu - \delta V]$, design $s(p)$ increases in p. Suppose in contrast value shoppers browse for prices $(\hat{p} - \epsilon, \hat{p})$ for some ϵ, and study for all prices bigger than $\hat{p}$, where $\hat{p} \in (\underline{p}, \mu - \delta V]$. We show that value shoppers browse for all prices below $\hat{p} - \epsilon$. Suppose in contrary that firms induce studying for prices in $(\hat{p} - \epsilon - \epsilon_2, \hat{p} - \epsilon)$. As firms earn the same profit for prices in $(\hat{p}-\epsilon, \hat{p})$, we have

$$\begin{aligned} &\frac{\partial p[(1-G(p))+\tilde{\alpha}(G(\hat{p})-G(p))]}{\partial p}=0 \\ \Leftrightarrow &\frac{(1-G(p))+\frac{\tilde{\alpha}}{1+\tilde{\alpha}}(G(\hat{p})-1)}{g(p)}=p. \end{aligned}$$

Thus, because $(G(\hat{p})-1) \leq 0$ and $1-G(p) \geq 1-G(\hat{p})$, $\frac{1-G(p)}{g(p)}$ increases in p and $g(p)$ decreases in p for $p \in (\hat{p}-\epsilon, \hat{p})$. Denote s_p as the solution of $U_{\text{study}} = U_{\text{browse}}$, which implies that $\delta V + p \in (\mu - s_p, \mu + s_p)$. Next because of weak log-concavity of F, $F_{s_{\hat{p}}}(\delta V + \hat{p}) \in (0,1)$, and $f \to 0$ when $\xi \to 0$, for $p \in (\hat{p}-\epsilon, \hat{p})$,

$$\frac{1-F_{s_{\hat{p}}}(\delta V+p)}{f_{s_{\hat{p}}}(\delta V+p)} \geq \frac{1-F_{s_{\hat{p}}}(\delta V+\hat{p})}{f_{s_{\hat{p}}}(\delta V+\hat{p})} > \frac{1-G(\hat{p})}{g(\hat{p})} > \frac{1-G(p)}{g(p)}. \tag{B.3}$$

The first inequality follows from the definition of log-concavity. The second inequality follows when $\xi \to 0$. The third inequality follows because $\frac{1-G(p)}{g(p)}$ increases in p for $p \in (\hat{p}-\epsilon, \hat{p})$, and since by Point 7 there is no mass point below $\mu - \delta V$.

Next, we use this result to show that

$$1-F_{s_p}(\delta V+p) < 1-F_{s_{\hat{p}}}(\delta V+p) < 1-G(p) \tag{B.4}$$

To see that the first inequality holds, note that

$$\frac{\partial s_p}{\partial p} = -\frac{\partial(U_{\text{study}}-U_{\text{browse}})}{\partial p} \Big/ \frac{\partial(U_{\text{study}}-U_{\text{browse}})}{\partial s} = -\frac{(1-G(p))-(1-F_{s_p}(\delta V+p))}{\frac{\partial(U_{\text{study}}-U_{\text{browse}})}{\partial s}}, \tag{B.5}$$

and for $p \in (\hat{p}-\epsilon, \hat{p})$, the fact that value shoppers browse implies that $(1-G(p)) > (1-F_{s_p}(\delta V+p))$ and $s_p > s_{\hat{p}}$, i.e. on $(\hat{p}-\epsilon, \hat{p})$ the design that makes value shoppers indifferent between browsing and studying decreases in p. Thus, since we have $\hat{p} \leq \mu - \delta V$ so that more dispersion lowers demand of studying value shoppers, it follows that $1-F_{s_p}(\delta V+p) < 1-F_{s_{\hat{p}}}(\delta V+p)$. To see that the second inequality holds, note that (B.3) implies that if $1-F_{s_{\hat{p}}}(\delta V+p) \approx 1-G(p)$ at some $p \in (\hat{p}-\epsilon, \hat{p})$, we must have $f_{s_{\hat{p}}}(\delta V+p) < g(p)$ and therefore $1-F_{s_{\hat{p}}}(\delta V+p) < 1-G(p)$. Together, this implies (B.4) and firms strictly prefer induce browsing than induce studying at $\hat{p}-\epsilon$. But since $F_{s_p}(\delta V+p)$ and by Point 7 $G(p)$ is continuous for all $p \leq \mu - \delta V$, it contradicts that firms are indifferent between inducing value shoppers to study or browse at $\hat{p}-\epsilon$. We conclude that if value shoppers browse with prices in $(\hat{p}-\epsilon, \hat{p})$, they browse for all prices lower than $\hat{p}$.

Next, we show the second part of the statement, i.e. that for $p \in (\hat{p}, \mu - \delta V]$, design $s(p)$ increases in p. Note that value shoppers study for such prices. Thus, firms must prefer to have them study, which holds if they have larger demand from studying than browsing value shoppers, i.e. $1 - F_{s_p}(\delta V + p) \geq 1 - G(p)$. Thus by (B.5), we have

$$\frac{\partial s_p}{\partial p} = -\frac{(1 - G(p)) - (1 - F_{s_p}(\delta V + p))}{\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial s}} \geq 0.$$

This implies the claim.

Points 1 to 8 imply that there are four equilibrium candidates of price distribution: 1.) prices equal $\arg\max_p p(1 - F_{\overline{s}}(\delta V + p))$ with probability 1 and value shoppers always study; 2.) prices are distributed in $[\underline{p}, \mu - \delta V] \cup \{\overline{p}\}$, and value shoppers study if and only if they see $\overline{p}$; 3.) prices are distributed in $[\underline{p}, \mu - \delta V] \cup \{\overline{p}\}$, and value shoppers study if and only if they see $p \geq \hat{p}$ where $\hat{p} \in [\underline{p}, \mu - \delta V]$; 4.) prices are distributed in $[\underline{p}, \overline{p}]$ where $\overline{p} \leq \mu - \delta V$, and value shoppers study if and only if they see $p \geq \hat{p}$ where $\hat{p} \in [\underline{p}, \overline{p}]$.

9. There exists an equilibrium where $p = p^M$ with probability 1 if and only if $\tilde{\alpha}(1 - F_{\overline{s}}(p^M + \delta V))p^M \geq \mu - \delta V$. When $\xi \to 0$, $p^M \to \mu + \overline{s} - \delta V$ and both value shoppers and bargain shoppers get payoff δV. Note that in an equilibrium where $p = p^M$ with probability 1, value shoppers study and bargain shoppers browse. Firms' best deviation is thus charging $p = \mu - \delta V$ and choosing $s = 0$, which gives profit $\mu - \delta V$. When $\xi \to 0$, firms' monopoly profit converges to p for $p \leq \mu - \overline{s} - \delta V < 0$, converges to $\frac{1}{2}p$ for $p \in (\mu - \overline{s} - \delta V, \mu + \overline{s} - \delta V]$ and equals to 0 for $p > \mu - \overline{s} - \delta V, \mu + \overline{s} - \delta V$. Thus, when $\xi \to 0$, $p^M \to \mu + \overline{s} - \delta V$, and both value shoppers and bargain shoppers get payoff that equals to the continuation payoff δV. The statement thus follows.

10. Suppose the equilibrium price distribution is non-deterministic, the parameters $\tilde{\alpha}$, μ, V and $\overline{s}$ uniquely pin down equilibrium price distribution $G(p)$, and designs $s(p)$ for $p \geq \hat{p}$, firms' profit and consumers surplus. $\overline{p}$ increases in $\overline{s}$. From point 1 to 8, a price distribution and design $s(p)$, where p is not p^M with probability 1, is an equilibrium if they satisfy:

$$
\begin{aligned}
&[(1-\tilde{\alpha})+\tilde{\alpha}+\tilde{\alpha}G(\hat{p})]\,\underline{p} = [(1-\tilde{\alpha})(1-G(p))+\tilde{\alpha}(1-G(p))+\tilde{\alpha}(G(\hat{p})-G(p))]\,p \text{ for } p<\hat{p};\\
&\hat{p} = \begin{cases} \mu-\delta V \text{ if } G(\mu-\delta V) < F_{s_{\mu-\delta V}}(\mu); \\ \{p<\mu-\delta V : G(\hat{p}) = F_{s_{\hat{p}}}(\delta V+\hat{p})\} \text{ otherwise;} \end{cases}\\
&[(1-\tilde{\alpha})+\tilde{\alpha}+\tilde{\alpha}G(\hat{p})]\,\underline{p} = \left[(1-\tilde{\alpha})(1-G(p))+\tilde{\alpha}(1-F_{s_p}(\delta V+p))\right] p \text{ for } p\in[\hat{p},\mu-\delta V);\\
&[(1-\tilde{\alpha})+\tilde{\alpha}+\tilde{\alpha}G(\hat{p})]\,\underline{p} = \tilde{\alpha}(1-F_{\overline{s}}(\delta V+\overline{p}))\overline{p};\\
&U_{\text{study}} = U_{\text{browse}} \text{ for } p\ge\hat{p} \text{ and } p\neq\overline{p};\\
&U_{\text{study}} < U_{\text{browse}} \text{ for } p<\hat{p};\\
&U_{\text{study}} = U_{\text{browse}} \text{ at } \overline{p}.
\end{aligned} \tag{B.6}
$$

The first condition guarantees that firms earn the same profits for all prices lower than $\hat{p}$ where all her assigned consumers browse. In this case the firm sells to browsing value shoppers assigned to the firm and bargain shoppers if they draw a larger price from the rival they browse, and to value shoppers assigned to a rival that browse and find the firm cheaper.

The second condition characterizes $\hat{p}$, such that value shoppers study if and only if $p>\hat{p}$. We either have $\hat{p}=\mu-\delta V$ if at this price firms strictly prefer to induce value shoppers to browse; or by Point 8 a unique price below $\mu-\delta V$ if at $p=\mu-\delta V$ firms prefer to induce value shoppers consumers to study.

The third condition guarantees that for $\hat{p}<\mu-\delta V$ firms earn the same profits for prices $p<\hat{p}$ and $p\in[\hat{p},\mu-\delta V)$. In the latter case they sell to bargain shoppers if they draw a larger price from a rival and to assigned studying value shoppers who draw a sufficiently-good match.

The fourth condition guarantees that for $\hat{p}=\mu-\delta V$ firms earn the same profits for prices $p<\hat{p}$ and $p=\overline{p}$, which is the price they will charge by Point 5. For $p=\overline{p}$, firms only sell to studying value shoppers who draw a sufficiently-good match.

Finally, the last conditions guarantee that consumers are indifferent between browsing and studying for p larger $\hat{p}$, and must strictly prefer browsing for other prices. This follows from our arguments in Point 7 and 7(cont.).

We prove the statement in four steps. First, ignoring the last condition in Equation (B.6) that $U_{\text{study}}=U_{\text{browse}}$ for $p=\overline{p}$, we show that given $\underline{p}$, the remaining conditions characterize a unique $\overline{p}$, $\hat{p}$, $G(p)$ for all p and a unique $s(p)$ for all $p\ge\hat{p}$. Second, again ignoring the condition in Equation (B.6) that $U_{\text{study}}=U_{\text{browse}}$ for $p=\overline{p}$, $\overline{p}$ strictly increases in $\underline{p}$. Third, given $\overline{p}$, there exists a unique $\overline{s}$ such that $U_{\text{study}}=U_{\text{browse}}$ for $p=\overline{p}$. Lastly, $U_{\text{study}}-U_{\text{browse}}$ at $\overline{p}$ strictly decreases in $\overline{p}$. Combined with the fact that $U_{\text{study}}-U_{\text{browse}}$ strictly increases in $\overline{s}$, there exists a one-to-one mapping from $\overline{s}$ to $\overline{p}$ and equilibrium $\overline{p}$ strictly increases in $\overline{s}$.

First, we ignore the condition that $U_{\text{study}} = U_{\text{browse}}$ for $p = \overline{p}$. Note that given $\underline{p}$ and $\hat{p}$, the rest of the conditions in Equation (B.6) uniquely pin down $\overline{p}$ and $G(p)$: first, take $p \to \hat{p}$, the first condition in (B.6) pins down $G(\hat{p})$, and thus also pin down $G(p)$ for all $p < \hat{p}$; second, using Conditions 3 and 5 recursively, it pins down $G(p)$ and $s(p)$ respectively from $\hat{p}$ up til $\overline{p}$. Next, we show that the remaining conditions and $\underline{p}$ uniquely pin down $\hat{p}$. Towards a contradiction, suppose that $\underline{p}$ does not uniquely pin down $\hat{p}$, and there are $\hat{p}$ and $\hat{p'} > \hat{p}$ that satisfy the rest of the conditions. Denote $G(p)$ and $G'(p)$ as the corresponding price distributions. By the Condition 1 in (B.6):

$$
\begin{aligned}
1 - G'(\hat{p'}) &= \frac{(1+\tilde{\alpha})\underline{p}}{\tilde{\alpha}\underline{p} + \hat{p'}}; \\
1 - G(\hat{p}) &= \frac{(1+\tilde{\alpha})\underline{p}}{\tilde{\alpha}\underline{p} + \hat{p}}.
\end{aligned}
$$

Thus, $\hat{p'} > \hat{p}$ implies $G'(\hat{p'}) > G(\hat{p})$. At $\hat{p}$, as $\hat{p} < \hat{p'} \leq \mu - \delta V$, by continuity, firms should be indifferent between inducing studying and browsing, i.e., $G(\hat{p}) = F_{s_{\hat{p}}}(\hat{p} + \delta V)$. Given that $\hat{p} + \delta V \in (\mu - s_{\hat{p}}, \mu + s_{\hat{p}})$ (as otherwise value shoppers strictly prefer to browse), when $\xi \to 0$, $F_{s_{\hat{p}}}(\hat{p} + \delta V)$ converges to $\frac{1}{2}$, it implies $G'(\hat{p'}) > G(\hat{p}) \approx \frac{1}{2}$ and contradicts condition 2. Thus, $\underline{p}$ uniquely pins down $\hat{p}$. Next, ignoring the condition that $U_{\text{study}} = U_{\text{browse}}$ for $p = \overline{p}$, suppose the rest of the conditions and $\underline{p}$ does not uniquely pin down $\overline{p}$, and there are $\overline{p}$ and $\overline{p'} > \overline{p}$ that satisfy the rest of the conditions. Denote $G(p)$ and $G'(p)$ as the corresponding price distributions. As firms must earn the same profit at $\overline{p}$ and $\hat{p}$ (at $\overline{p'}$ and $\hat{p'}$), we have

$$
\begin{aligned}
(1 - G'(\hat{p'}))\hat{p'} &= (1 - F_{\overline{p'}}(\delta V + \overline{p'}))\overline{p'} \\
(1 - G(\hat{p}))\hat{p} &= (1 - F_{\overline{p}}(\delta V + \overline{p}))\overline{p}.
\end{aligned}
$$

As $\underline{p}$ uniquely pins down $\hat{p}$, we have $\hat{p} = \hat{p'}$ and $(1 - G'(\hat{p'})) > (1 - G(\hat{p}))$ or equivalently $G(\hat{p}) < G'(\hat{p'})$. However, condition 4 implies $G'(\hat{p'}) > G(\hat{p})$ and we have a contradiction.

Second, we prove that $\overline{p}$ strictly increases in $\underline{p}$. Suppose not, and combined with the fact that $\overline{p} = 0$ if $\underline{p} = 0$ and $p^M \to p^M$ when $\underline{p} \to \mu - \delta V$, there exists some $\overline{p}$ such that there exists two infimum prices $\underline{p}$ and $\underline{p'}$ that satisfy the conditions in Equation (B.6). Without loss of generality, suppose $\underline{p'} > \underline{p}$, and denote G' and G, $\hat{p'}$ and $\hat{p}$ as the corresponding c.d.f. and threshold of the price distribution. By the forth condition in (B.6), we must have $G'(\hat{p'}) < G(\hat{p})$. As G and G' has the same supremum price and profit, we then must have $\hat{p'} < \hat{p}$, which is impossible when $\xi \to 0$ as argued above.

Third, as both U_{study} and U_{browse} are continuous, and U_{study} is strictly monotone in s, for a given $\overline{p}$ and the corresponding price distribution and designs, there exists a unique $\overline{s}$ such that $U_{\text{study}} = U_{\text{browse}}$ for $p = \overline{p}$.

Lastly, we prove that such $U_{\text{study}} = U_{\text{browse}}$ strictly decreases in $\overline{p}$ when $\xi \to 0$. We also take $\delta = 0$ to ease exposition. The results hold for small enough ξ and δ by continuity. Note that when $\xi \to 0$, the distribution converges to the binomial distribution in the baseline model. We consider two cases. Case 1: $\frac{\tilde{\alpha}}{2}\overline{p} > \frac{1}{2}(\mu)$; Case 2: $\frac{\tilde{\alpha}}{2}\overline{p} \leq \frac{1}{2}(\mu)$. In case 1, we must have $1 - G(\mu) > \frac{1}{2}$ and firms induce browsing at price equal to μ. Firms must earn the same profit at $\overline{p}$ and $p < \mu$:

$$[\tilde{\alpha}(1 - G(p) + G(\mu) - G(p)) + (1 - \tilde{\alpha})(1 - G(p))]\, p = \frac{\tilde{\alpha}}{2}\overline{p}$$

where $1 - G(p)$ is the probability of selling to a browsing value or bargain shopper, and $G(\mu) - G(p)$ is the probability of selling to rival's browsing value shopper. Solving the equations gives us the c.d.f. and p.d.f. of the equilibrium prices:

$$1 - G(p) = \frac{\tilde{\alpha}}{2(1+\tilde{\alpha})} \frac{\overline{p} + 2(1 - G(\mu))p}{p} \text{ for } p \leq \mu; \tag{B.7}$$

$$g(p) = \frac{\tilde{\alpha}}{2(1+\tilde{\alpha})} \frac{\overline{p}}{p^2} \text{ for } p \leq \mu. \tag{B.8}$$

Moreover, by Equation (B.7), we have

$$1 - G(\mu) = \frac{\tilde{\alpha}}{2} \frac{\overline{p}}{\mu}. \tag{B.9}$$

We denote proportion of studying value shoppers $\lambda = 1 - G(\mu)$, and by Equation (B.9) and by Equation (B.8), we have

$$\begin{aligned} \overline{p} &= \frac{2\mu\lambda}{\tilde{\alpha}}, \text{ and} \\ \int_{\underline{p}}^{\mu} p g(p)\, dp = \int_{\underline{p}}^{\mu} \frac{\tilde{\alpha}}{2(1+\tilde{\alpha})} \frac{\overline{p}}{p}\, dp &= \frac{\tilde{\alpha}\overline{p}}{2(1+\tilde{\alpha})} \left(\log\left(\frac{\mu}{\overline{p}} \frac{2(1+\tilde{\alpha}) - 2\tilde{\alpha}(1 - G(\mu))}{\tilde{\alpha}}\right) \right). \end{aligned} \tag{B.10}$$

where the last Equality uses the condition that firms earn the same profit at $\underline{p}$ and $\overline{p}$. Substituting the Equations (B.10) to U_{study} and U_{browse} at $\overline{p}$ gives us:

$$\begin{aligned} &U_{\text{study}} - U_{\text{browse}} \\ =&\frac{1}{2}\left(\mu + \overline{s} - \frac{2\mu\lambda}{\tilde{\alpha}}\right) - (1-\lambda)\mu + \frac{\tilde{\alpha}\overline{p}}{2(1+\tilde{\alpha})} \left(\log\left(\frac{\mu}{\overline{p}} \frac{2(1+\tilde{\alpha}) - 2\tilde{\alpha}(1 - G(\mu))}{\tilde{\alpha}}\right) \right) \\ \propto&\frac{1}{2}\left(\frac{\overline{s}}{\mu} - 1\right) + \lambda\left[1 - \frac{1}{\tilde{\alpha}} + \left(\frac{1}{1+\tilde{\alpha}} \log\left(\frac{1+\tilde{\alpha} - \tilde{\alpha}\lambda}{\lambda}\right)\right)\right]. \end{aligned}$$

The derivative of $U_{\text{study}} - U_{\text{browse}}$ is:

$$\begin{aligned}
&\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial\lambda} \\
\propto& 1 - \frac{1}{\tilde{\alpha}} + \left(\frac{1}{1+\tilde{\alpha}}\log\left(\frac{1+\tilde{\alpha}-\tilde{\alpha}\lambda}{\lambda}\right)\right) \\
=& 1 - \frac{1}{\tilde{\alpha}} + \left(\frac{1}{1+\tilde{\alpha}}\log\left(\frac{1+\tilde{\alpha}-\tilde{\alpha}\lambda}{\lambda}\right)\right) + \frac{1}{1+\tilde{\alpha}}\frac{\lambda}{1+\tilde{\alpha}-\tilde{\alpha}\lambda}\frac{-\tilde{\alpha}\lambda - 1 - \tilde{\alpha} + \tilde{\alpha}\lambda}{\lambda^2} \\
=& 1 - \frac{1}{\tilde{\alpha}} + \left(\frac{1}{1+\tilde{\alpha}}\log\left(\frac{1+\tilde{\alpha}-\tilde{\alpha}\lambda}{\lambda}\right)\right) - \frac{1}{\lambda(1+\tilde{\alpha}-\tilde{\alpha}\lambda)} \\
=& -\frac{1}{2}\left(\frac{\overline{s}}{\mu} - 1\right) - \frac{1}{\lambda(1+\tilde{\alpha}-\tilde{\alpha}\lambda)} < 0
\end{aligned} \tag{B.11}$$

where the last Equality is implied by $U_{\text{study}} - U_{\text{browse}} = 0$ at $\overline{p}$ and the last Inequality is implied by $\overline{s} > \mu$ ($\underline{v} = \mu - \overline{s} < 0$). And the result follows as λ increases in $\overline{p}$.

We now consider case 2, $\frac{\tilde{\alpha}}{2}\overline{p} \leq \frac{1}{2}(\mu)$. It implies that $1 - G(\mu) \leq \frac{1}{2}$ and there exists $\hat{p} \leq \mu$ such that firms induce studying for $p \geq \hat{p}$ and browsing for $p < \hat{p}$. As firms earn the same profits for $p \geq \hat{p}$ and $\underline{p}$:

$$\left[\frac{\tilde{\alpha}}{2} + (1-\tilde{\alpha})(1-G(p))\right]p = \frac{\tilde{\alpha}}{2}\overline{p} = \frac{2+\tilde{\alpha}}{2}\underline{p}$$

For $p < \hat{p}$:

$$\left[\tilde{\alpha}(1 - G(p) + G(\hat{p}) - G(p)) + (1-\tilde{\alpha})(1-G(p))\right]p = \frac{\tilde{\alpha}}{2}\overline{p} = \frac{2+\tilde{\alpha}}{2}\underline{p}$$

Solving the equations give us the c.d.f. and p.d.f. of the equilibrium prices:

$$1 - G(p) = \begin{cases} \dfrac{\tilde{\alpha}}{2(1-\tilde{\alpha})}\dfrac{\overline{p}-p}{p} & \text{for } p \geq \hat{p} \text{ and } p \neq \overline{p}; \\ \dfrac{\tilde{\alpha}}{2(1+\tilde{\alpha})}\dfrac{\overline{p}+p}{p} & \text{for } p < \hat{p}; \end{cases} \tag{B.12}$$

$$g(p) = \begin{cases} \dfrac{\tilde{\alpha}}{2(1-\tilde{\alpha})}\dfrac{\overline{p}}{p^2} & \text{for } p > \hat{p} \text{ and } p \neq \overline{p}; \\ \dfrac{\tilde{\alpha}}{2(1+\tilde{\alpha})}\dfrac{\overline{p}}{p^2} & \text{for } p < \hat{p}. \end{cases} \tag{B.13}$$

$G(\hat{p}) = \frac{1}{2}$ implies $\hat{p} = \tilde{\alpha}\overline{p}$. At $\overline{p}$, $U_{\text{study}} - U_{\text{browse}}$ follows:

$$\begin{aligned}
U_{\text{study}} - U_{\text{browse}} &= \frac{1}{2}(\overline{p} + \overline{s} - \mu) - [\overline{p} - E_G(p)] \text{ if } \overline{p} \leq \mu, \text{ or;} \\
U_{\text{study}} - U_{\text{browse}} &= \frac{1}{2}(\mu + \overline{s} - \overline{p}) - G(\mu)\left(\mu - E_G(p \mid p < \mu)\right) \text{ if } \overline{p} > \mu.
\end{aligned} \tag{B.14}$$

Using the c.d.f. and p.d.f. in equation (B.12) and (B.13), we obtain the expected price and the truncated expected price as a function of $\overline{p}$: When $\overline{p} \le \mu$:

$$E_G(p) = \frac{\tilde{\alpha}\overline{p}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right),$$

and when $\overline{p} > \mu$,

$$G(\mu)E_G(p \mid p < \mu) = \int_{\underline{p}}^{\mu} pg(p)\,dp = \frac{\tilde{\alpha}\overline{p}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{\mu}{\tilde{\alpha}\overline{p}})\right).$$

We will divide the proof into two cases, corresponding to the sign of

$$-\frac{1}{2} + \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right).$$

1. $-\frac{1}{2} + \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right) < 0$**.** Using the expected price and the truncated expected price we obtained above, for $\overline{p} \le v$, we have

$$\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial \overline{p}} = -\frac{1}{2} + \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right) < 0.$$

On the other hand, for $\overline{p} > \mu$

$$\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial \overline{p}} = -\frac{1}{2} + \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{\mu}{\tilde{\alpha}\overline{p}})\right) - \frac{\tilde{\alpha}\overline{p}}{2(1-\tilde{\alpha})}\frac{\tilde{\alpha}\overline{p}}{\mu}\frac{\mu}{\tilde{\alpha}\overline{p}^2} < 0$$

where the last inequality is guaranteed as $\overline{p} > \mu$, and thus $\log(\frac{1}{\tilde{\alpha}}) > \log(\frac{\mu}{\tilde{\alpha}\overline{p}})$.

2. $-\frac{1}{2} + \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right) \ge 0$**.** In this case, $\overline{p} > \mu$ as otherwise we have:

$$\begin{aligned} U_{\text{study}} &= U_{\text{browse}} \\ \frac{1}{2}(\overline{p} + \overline{s} - \mu) &= \overline{p} - \frac{\tilde{\alpha}\overline{p}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right) \\ \overline{p} &= \frac{\overline{s} - \mu}{\frac{1}{2} - \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right)} \end{aligned}$$

which is either negative or ∞. Thus we look at the case where $\overline{p} > \mu$. From previous computation, we have

$$\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial \overline{p}} = -\frac{1}{2} + \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{\mu}{\tilde{\alpha}\overline{p}})\right) - \frac{1}{2(1-\tilde{\alpha})}$$

which is monotonically decreasing in $\overline{p}$. It implies that $U_{\text{study}} - U_{\text{browse}}$ is single peaked: It either is decreasing in $\overline{p}$ for all $\overline{p} > \mu$, or it is increasing in $\overline{p}$ at $\overline{p} = \mu$ and decreasing in $\overline{p}$ if and only if $\overline{p}$ is big enough. We conclude that $U_{\text{study}} - U_{\text{browse}}$ strictly decreases in $\overline{p}$ in the former case. In the latter case, first note that $U_{\text{study}} - U_{\text{browse}} > 0$ if $\overline{p} = \mu$, i.e., we have:

$$
\begin{aligned}
&U_{\text{study}} - U_{\text{browse}} \\
=&\frac{1}{2}(\mu + \overline{s} - \overline{p}) - G(\mu)\mu + \frac{\tilde{\alpha}\overline{p}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{\mu}{\tilde{\alpha}\mu})\right) \\
=&(\frac{1}{2} - G(\mu))\mu + \frac{1}{2}\overline{s} + \mu\left[-\frac{1}{2} + \frac{\tilde{\alpha}}{2}\left(\frac{1}{1+\tilde{\alpha}}\log(2+\tilde{\alpha}) + \frac{1}{1-\tilde{\alpha}}\log(\frac{1}{\tilde{\alpha}})\right)\right] \\
>&0.
\end{aligned}
$$

Denote $\mathscr{G}$ as $U_{\text{study}} - U_{\text{browse}}$. Note that if $\mathscr{G}$ first increases at prices close to μ and then strictly decreases, by continuity, there exists a unique $p' > \mu$ such that $\mathscr{G}(p') = \mathscr{G}(\mu) > 0$. Thus, for prices $p \in (\mu, p')$, $\mathscr{G}(p) > 0$, and because $\mathscr{G}(\overline{p}) = 0$, we must have $\overline{p} > p'$. Lastly, as $\mathscr{G}(\cdot)$ is strictly decreasing for prices above p', $\mathscr{G}(\cdot)$, equivalently $U_{\text{study}} - U_{\text{browse}}$, strictly decreases in $\overline{p}$ at $\overline{p}$. As $U_{\text{study}} - U_{\text{browse}}$ strictly increases in $\overline{s}$, we conclude that $\overline{p}$ strictly increases in $\overline{s}$, i.e.,

$$
\frac{\partial \overline{p}}{\partial \overline{s}} = -\frac{\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial \overline{s}}}{\frac{\partial(U_{\text{study}} - U_{\text{browse}})}{\partial \overline{p}}} > 0.
$$

As $\overline{p}$ increases $\overline{s}$, there exists threshold $\overline{s}_L$ such that $\overline{p} \leq \mu - \delta V$ when $\overline{s} \leq \overline{s}_L$.

11. There exists a non-deterministic equilibrium price distribution if and only if $\tilde{\alpha}(1 - F_{\overline{s}}(p^M + \delta V))p^M < \mu - \delta V$. Denote a sequence of $\{\overline{s}_n\}$ where $\lim_{n\to\infty} \overline{s}_n = \overline{s'}$ such that the equilibrium infimum price converges to $\mu - \delta V$. By point 10, there exists a non-deterministic equilibrium price distribution if and only if $\overline{s} < \overline{s'}$ (as $\overline{p}$ strictly increases in $\overline{s}$). When the equilibrium infimum prices converge to $\mu - \delta V$, U_{browse} converges to 0, and thus $\overline{p}$ converges to p^M. The equilibrium supremum price is thus continuous at $\overline{s'}$. The statement thus follows as $\overline{s'}$ is pinned down by Point 9.

12. When δ is small enough, there exists unique equilibrium continuation payoff V for all active consumers who purchase with strictly positive probability, and a unique equilibrium long-run proportion of value shoppers $\tilde{\alpha}$. Note that when value shoppers study and bargain shoppers purchase with strictly-positive probability, they are made indifferent between studying and browsing. Thus, the equilibrium and continuation payoff of value shoppers equals that of bargain shopper, unless firms charge $p_M > \mu - \delta V$ with probability one and bargain shoppers do not purchase. Thus, all active consumers have the same continuation payoff V. In a stationary equilibrium, V is pinned down by the following equation

$$
V = \text{CS}(\mu, \delta V, \overline{s}, \tilde{\alpha}), \tag{B.15}
$$

where the function CS is the single period consumer surplus and $\tilde{\alpha}$ follows:

$$\tilde{\alpha} = \frac{\alpha}{1-\delta \mathrm{P}_v(\text{search on})} \Big/ \left[\frac{\alpha}{1-\delta \mathrm{P}_v(\text{search on})} + \frac{1-\alpha}{1-\delta \mathrm{P}_b(\text{search on})}\right].$$

Note that $\tilde{\alpha}$ is given by the geometric sum formula, and $\mathrm{P}_v(\text{search on})$ and $\mathrm{P}_b(\text{search on})$ are the probability that value shoppers and bargain shoppers search on to the next period. As the function CS is continuous and bounded, and when δ is small enough, it is a contraction mapping. Thus, according to the Banach fixed-point theorem, a unique fixed-point solution exists. Finally, by point 10, given a unique V, there exist unique $\mathrm{P}_v(\text{search on})$ and $\mathrm{P}_b(\text{search on})$, and thus a unique equilibrium long-run proportion of value shoppers $\tilde{\alpha}$. □

B.6 Proof of Proposition 5

Proof. We first prove that when $\delta = 0$, value and bargain shoppers' surplus decreases and firms' profit increases in $\overline{s}$. The first part of the proposition then follows from continuity.

When $\delta = 0$, the game becomes a one-period game, where the value of continuing search equals to 0. Firms' profits is proportional to $\alpha\,(1 - F_{\overline{s}}(\overline{p}))\,\overline{p}$. We distinguish two cases. Case 1: $\overline{p} > \mu$; Case 2: $\overline{p} \leq \mu$. We first consider case 1. As $1 - F_{\overline{s}}(p)$ is weakly log-concave and there exists a unique monopoly price, $(1 - F_{\overline{s}}(\overline{p}))\,\overline{p}$ strictly increases in $\overline{p}$ for $\overline{p} < p^M$. The result follows as $\overline{p}$ and $1 - F_{\overline{s}}(\overline{p})$ strictly increases in $\overline{s}$. Now we consider case 2, when $\xi \to 0$, $1 - F_{\overline{s}}(p) \to \frac{1}{2}$ for all $p \in (0, \mu + \overline{s})$, firms' profit converges to $\frac{\alpha}{2}\overline{p}$. The result then follows as $\overline{p}$ strictly increases in $\overline{s}$.

Now, we prove that value and bargain shoppers' surplus decrease in $\overline{s}$. Because we focus on $\overline{s} < \overline{s}_H$, bargain shoppers purchase with strictly positive probability in equilibrium. As, in equilibrium, studying value shoppers are indifferent between studying and browsing, they get the same expected surplus as bargain shoppers and it suffices to prove that the utility of browsing decreases in $\overline{s}$ for all initial prices p. Consider first the case where $p < \hat{p}$ such that value shoppers browse. Because firms must earn the same expected profits for all prices in their equilibrium support, we must have:

$$\begin{aligned} & \alpha(1 - F_{\overline{s}}(\overline{p}))\overline{p} = \left[(1 - G(p)) + \alpha(G(\hat{p}) - G(p))\right] p \\ \Leftrightarrow \quad & \alpha(1 - F_{\overline{s}}(\overline{p}))\overline{p} = \left[(1+\alpha)(1 - G(p)) - \alpha(1 - G(\hat{p}))\right] p \end{aligned} \tag{B.16}$$

The L.H.S. is firms' profits when they charge $\overline{p}$ and sell to their own studying value shoppers (the proportion equals to α as $\delta = 0$). The R.H.S. is firms' profits when they charge $p < \hat{p}$, in which value shoppers browse. The first term inside the square bracket of the R.H.S. is the demand of browsing bargain shoppers and firms' own browsing value shoppers. The second term captures that value shoppers assigned to rivals may draw a price below $\hat{p}$ and browse the firm.

The L.H.S. increases in $\overline{s}$ because firms' profit increases in $\overline{s}$. Now, if $1-G(\hat{p})$ decreases in $\overline{s}$, for $p \to \hat{p}$, Point 7 in the proof of Proposition 4 implies that $G(\cdot)$ has no mass points at $\hat{p}$ and thus the R.H.S decreases in $\overline{s}$, and we have a contradiction. Thus, when $\overline{s}$ increases, value shoppers study with a larger probability, i.e., $1 - G(\hat{p})$ increases in $\overline{s}$. Equation (B.16) also implies that $1-G(p)$ increases in $\overline{s}$ for all $p \leq \hat{p}$. As prices increase in the sense of F.O.S.D., U_{browse} decreases for all $p \leq \hat{p}$.

Now consider $p \in [\hat{p}, \mu)$ such that value shoppers study. Because firms must earn the same expected profits for all prices in their equilibrium support, we must have:

$$\alpha(1 - F_{\overline{s}}(\overline{p}))\overline{p} = \left[(1-\alpha)(1-G(p)) + \frac{\alpha}{2}(1 - F_{s_p}(p))\right] p \tag{B.17}$$

The L.H.S. are the profits that a firm earns when charging $\overline{p}$ as they sell only to their own studying value shoppers. This must equal the profits from prices $p \in [\hat{p}, \mu)$, which are on the R.H.S.. In this case, the firm sells to initially-assigned bargain shoppers if it is cheaper than the other firm they browse, and to value shoppers who study and get a good match.

Suppose in contrast U_{browse} increases in $\overline{s}$ for some $p \in (\hat{p}, \mu]$, and without loss, take the infimum of such prices and denote it as p. Because U_{browse} increases at p but decreases for smaller prices, $1-G(p)$ must decrease in $\overline{s}$ at p. Now as U_{browse} increases in $\overline{s}$, because for this price range, value shoppers are indifferent between browsing and studying, it implies that s_p increases in $\overline{s}$, and $1 - F_{s_p}(p)$ decreases in $\overline{s}$ as $p < \mu$. Equation (B.17) then implies that $1 - G(p)$ increases in $\overline{s}$, and we have a contradiction. By continuity, U_{browse} also decreases in $\overline{s}$ at $p = \mu$.

Lastly, for $p > \mu$, the utility of browsing equals to the utility of browsing at μ, which decreases in $\overline{s}$ as shown above. The result follows.

For the second part of the proposition, note that when $\delta = 1$, consumers can search indefinitely and buy only if the firm offers the largest value minus the price. Firms must choose $p = 0$ and $\overline{s}$ with probability 1. Value shoppers surplus equals $\mu + \overline{s}$, and bargain shoppers surplus equals μ. The result thus follows. □

B.7 Proof of Proposition A.1

Proof. First, note that increasing s always weakly increases profit. Thus, if there exists an equilibrium in which $s < \overline{s}$ with some probability, there must exist an equilibrium in which $s = \overline{s}$ with probability 1 and with the same equilibrium price distribution. In other words, it is without loss of generality to assume $s = \overline{s}$ when we characterize the price equilibrium. In the following, we assume $s = \overline{s}$ for both firms and characterize the price equilibrium, and then verify that there must not exist an equilibrium where $s < \overline{s}$.

In a symmetric equilibrium, at the supremum of the equilibrium price distribution, firms must only sell to the price-insensitive consumers, i.e., the value shoppers who find the match value of only one firm as high. Otherwise, it implies that there is a mass point at the supremum, and firms have incentive to undercut, which yields a jump in demand but only a marginal decrease in profit margin. Thus, firms' profit equals to $\frac{\alpha}{4}\overline{p}$. But firms can ensure profit equals to $\frac{\alpha}{4}(\mu+\overline{s})$ by charging $v+\overline{s}$ and as they sell to no consumers if $\overline{p}>\mu+\overline{s}$, $\overline{p}=\mu+\overline{s}$. As firms put no mass point at $\overline{p}$, value shoppers buy with probability 1 if their match value with at least one of the firms is $v+\overline{s}$.

A similar argument proves that firms put no mass point at any prices, as otherwise firms have incentive to undercut. There could also be no gaps (p,p') where $p'<\mu$, as firms can deviate from prices at or just below p to $p'-\epsilon$ and $\overline{s}$ that induces the same demand but higher profit margin compared to charging price p. Similarly, there could also be no gaps (p,p') where $p>\mu$. Thus there are two possible candidates of equilibrium price distribution, where the first corresponds to a distribution with no gaps and support $[\underline{p},\mu+\overline{s}]$ where $\underline{p}>\mu$, and the second corresponds to a distribution with one gap and support $[\underline{p},\mu]\cup(\tilde{p},\mu+\overline{s}]$ for some $\tilde{p}\geq\mu$. Next, when the support of the equilibrium price is $[\underline{p},\mu+\overline{s}]$ where $\underline{p}>\mu$, we have

$$\left[\frac{\alpha}{4}+\frac{\alpha}{4}+(1-\alpha)\right]\mu\leq\frac{\alpha}{4}(\mu+\overline{s}),$$

i.e., deviating to price μ is not profitable. In contrast, when the support of the equilibrium price is $[\underline{p},\mu]\cup(\tilde{p},\mu+\overline{s}]$ for some $\tilde{p}\geq\mu$, by the equal profit condition, we have

$$\left[\frac{\alpha}{4}+(\frac{\alpha}{4}+1-\alpha)(1-G(\mu))\right]\mu=\frac{\alpha}{4}(\mu+\overline{s})$$

for some $1-G(\mu)<1$. Thus, the two candidates of equilibrium price distribution cannot co-exist, and so the equilibrium price distribution must be unique.

Now we verify that there must not exist an equilibrium where $s<\overline{s}$. Note that for all $p\neq\underline{p},\tilde{p}$ and $p<\mu+\overline{s}$, decreasing s while keeping fixed the equilibrium price distribution strictly decreases demand from the price sensitive value shoppers, i.e., value shoppers who find match value from both firms to be high. Additionally, because $\underline{s}>\mu$, consumers who have a good match with at most one of the firms will not change their demand. Thus, increasing s for given prices strictly increases demand. We conclude that firms must choose $s=\overline{s}$ at all prices except at $p=\underline{p}$ or $p=\tilde{p}$, and as there are no mass points at $p=\underline{p}$ and $p=\tilde{p}$, firms choose $s=\overline{s}$ with probability 1. This concludes the proof. $\square$

B.8 Proof of Corollary A.1

Proof. We prove the corollary in two cases, i.e., $\frac{\bar{s}}{\mu} \geq \frac{4-3\alpha}{\alpha}$ or $\frac{\bar{s}}{\mu} < \frac{4-3\alpha}{\alpha}$. First, we consider the case where $\frac{\bar{s}}{\mu} \geq \frac{4-3\alpha}{\alpha}$. In this case, we have

$$\frac{\alpha}{4}(\mu + \bar{s}) \geq \left[\frac{\alpha}{4} + (\frac{\alpha}{4} + 1 - \alpha)\right]\mu$$

and thus $\underline{p} \geq \mu$. Total surplus is thus equal to $\frac{3\alpha}{4}(\mu+\bar{s})$. Each firm's profit equals $\frac{\alpha}{4}(\mu+\bar{s})$ which increases in $\bar{s}$. Bargain shoppers' surplus equals to 0 and thus is unchanged with $\bar{s}$. Average consumer surplus is equal to total surplus minus the two firms' profits, i.e., $\frac{\alpha}{4}(v + \bar{s})$, and increases in $\bar{s}$.

Now, we consider the case where $\frac{\bar{s}}{\mu} < \frac{4-3\alpha}{\alpha}$. In this case, we must have

$$\begin{aligned}\left[\frac{\alpha}{4} + (\frac{\alpha}{4} + 1 - \alpha)(1 - G(\mu))\right]\mu &= \frac{\alpha}{4}(\mu + \bar{s}) \\ 1 - G(\mu) &= \frac{\alpha}{4-3\alpha}\frac{\bar{s}}{\mu} \\ G(\mu) &= 1 - \frac{\alpha}{4-3\alpha}\frac{\bar{s}}{\mu}.\end{aligned}$$

Total surplus in this case is equal to:

$$\frac{3\alpha}{4}(\mu + \bar{s}) + (1-\alpha)G(\mu)\mu = \frac{3\alpha}{4}(\mu + \bar{s}) + (1-\alpha)(\mu - \frac{\alpha}{4-3\alpha}\bar{s}).$$

Again, firms' profit equals $\frac{\alpha}{4}(\mu + \bar{s})$ which increases in $\bar{s}$. Average consumers' surplus is equal to the total surplus minus the industry's profit:

$$\frac{\alpha}{4}(\mu + \bar{s}) + (1-\alpha)(\mu - \frac{\alpha}{4-3\alpha}\bar{s}).$$

Simple differentiation shows that the first derivative with respect to $\bar{s}$ equals $\frac{\alpha^2}{4(4-3\alpha)} > 0$ as $\alpha < 1$. Next, bargain shoppers' surplus is equal to

$$G(v)\left[\mu - E(p|p \leq \mu)\right]$$

As $G(\mu)$ decreases in $\bar{s}$, and p increases in the sense of F.O.S.D. in $\bar{p}$, bargain shoppers' surplus decreases in $\bar{s}$. Last, as average consumers' surplus increases but bargain shoppers' surplus decreases in $\bar{s}$, value shoppers' surplus must increase in $\bar{s}$. □

B.9 Proof of Corollary A.2

Proof. We prove the corollary in two cases, i.e., $\frac{\bar{s}}{\mu} \geq \frac{4-3\alpha}{\alpha}$ or $\frac{\bar{s}}{\mu} < \frac{4-3\alpha}{\alpha}$. In the first case, as shown in the proof of Corollary A.1, firms' profit and average consumer surplus equal to $\frac{\alpha}{4}(\mu+\overline{s})$, and thus increases in v.

Now, we consider the case where $\frac{\overline{s}}{\mu} < \frac{4-3\alpha}{\alpha}$. As shown in the proof of Corollary A.1, total surplus is equal to

$$\frac{3\alpha}{4}(\mu+\overline{s}) + (1-\alpha)G(\mu)\mu = \frac{3\alpha}{4}(\mu+\overline{s}) + (1-\alpha)(\mu - \frac{\alpha}{4-3\alpha}\overline{s}).$$

First, firms' profit equals to $\frac{\alpha}{4}(\mu+\overline{s})$ which increases in μ. Second, average consumers' surplus equals to the total surplus minus the industry's profit, which is equal to

$$\frac{\alpha}{4}(\mu+\overline{s}) + (1-\alpha)(\mu - \frac{\alpha}{4-3\alpha}\overline{s})$$

and obviously increases in μ. □

B.10 Proof of Proposition A.2

Proof. We want to show that an equilibrium like Proposition 1 exists where firms do not want to make information easily available. To start with, take such a candidate equilibrium as in Proposition 1.

First, we prove that firms that choose small p to induce browsing do not want to choose $A_k = 1$. First, as deviating to $s = 0$ and $A_k = 1$ does not change the demand, it is not profitable. Next, note that in the baseline model, for low p, firms prefer inducing browsing to inducing studying, and thus prefer choosing $s = 0$ with $A_k = 0$ to $s = \overline{s}$ with $A_k = 0$. Moreover, when $s = \overline{s}$, consumers buy only if they find a good match, firms would make (weakly) less sales when choosing $s = \overline{s}$ and $A_k = 1$. Thus, for low p, deviating to $s = \overline{s}$ and $A_k = 1$ is not profitable.

Second, we prove that firms that choose large p to induce studying do not want to choose $A_k = 1$. Note that in the baseline model, for high p, firms prefer to induce studying to induce browsing, and thus prefer choosing $s = \overline{s}$ with $A_k = 0$ to $s = 0$ with $A_k = 0$. As choosing $s = 0$ and $A_k = 1$ gives the same profit as choosing $s = 0$ with $A_k = 0$, it also implies that firms prefer choosing $s = \overline{s}$ with $A_k = 0$ to choosing $s = 0$ and $A_k = 1$. Moreover, as deviating any $s = \overline{s}$ with $A_k = 1$ induces at most demand from half of the value shoppers, the deviation to $s = \overline{s}$ with $A_k = 1$ is not profitable.

Third, we prove that it is not profitable for firms to deviate to a price smaller than $\overline{p}$ and not in the equilibrium support. First, at $\underline{p}$ they already sell to all their own matched consumers and the browsing consumers from their rival, and they can never sell to the studying consumers of their rival. Thus, charging price to smaller than $\underline{p}$ does not increase demand and is not profitable. Now suppose that there is a gap $(v, \overline{p})$, at these prices, firms can only sell to studying consumers and thus sell to at most half of their matched value shoppers. It is thus more profitable for firms to charge $\overline{p}$, $s_k = \overline{s}$ and $A_k = 0$ than to charge any prices in $(v, \overline{p})$ with $A_k = 0$ or $A_k = 1$.

Finally, we prove that it is not profitable for firms to deviate to a price higher than $\overline{p}$. First note that it obviously hold when $\overline{s} \geq \frac{4-3\alpha}{\alpha}\mu$ as $\overline{p} = \underline{p} = \mu + \overline{s}$. For $\overline{s} < \frac{4-3\alpha}{\alpha}\mu$, it is sufficient to prove that first, $\mu + \overline{s} - \overline{p} \leq \mu - \underline{p}$ such that for value shoppers, the value of a good match at $\overline{p}$ must be below the best possible value from browsing the rival, as otherwise firms might have incentive to deviate to $p' = \overline{p} + \epsilon$, $\overline{s}$ and $A_k = 1$ for small $\epsilon > 0$, and second,

$$\frac{\alpha}{4}(1 - G(p - \overline{s}))p \text{ is decreasing in } p \text{ for } p \geq \overline{p},$$

that is, the profit of deviating to $\overline{s}$, $p \geq \overline{p}$ and $A_k = 1$ is decreasing in p.

We first prove the first statement, that $\mu + \overline{s} - \overline{p} \leq \mu - \underline{p}$ is true for big enough $\overline{s}$ and α. First note that for $\overline{s} \to \frac{4-3\alpha}{\alpha}\mu$, $\overline{p} \to \mu + \overline{s}$ and $\underline{p} \to \mu$ and the inequality holds at the limit. We now show that it also holds as one approaches the limit. To do so, we prove $\frac{\partial(\overline{s}-\overline{p}+\underline{p})}{\partial \overline{s}} > 0$ for big enough α and $\overline{s}$ with $\overline{s} < \frac{4-3\alpha}{\alpha}\mu$. Recalling that in the Equilibrium characterized in Proposition 1, $\underline{p} = \frac{\alpha}{4-2\alpha(1-G(\mu))}\overline{p}$ and $(1 - G(\mu)) = \frac{\alpha}{2(2-\alpha)}\frac{\overline{p}}{\mu}$, we have

$$\begin{aligned}
\frac{\partial(\overline{s} - \overline{p} + \underline{p})}{\partial \overline{s}} &= 1 - \frac{\partial \overline{p}}{\partial \overline{s}} + \frac{\alpha}{4 - 2\alpha(1 - G(\mu))}\frac{\partial \overline{p}}{\partial \overline{s}} + \frac{\alpha \overline{p}}{(4 - 2\alpha\frac{\alpha \overline{p}}{2(2-\alpha)\mu})^2}\frac{\alpha^2}{(2 - \alpha)\mu}\frac{\partial \overline{p}}{\partial \overline{s}} \\
&= 1 - \frac{\partial \overline{p}}{\partial \overline{s}} + \frac{4\alpha}{(4 - 2\alpha\frac{\alpha \overline{p}}{2(2-\alpha)\mu})^2}\frac{\partial \overline{p}}{\partial \overline{s}} \\
&= 1 + \left[\frac{4\alpha}{(4 - \frac{\alpha^2 \overline{p}}{(2-\alpha)\mu})^2} - 1\right]\frac{\partial \overline{p}}{\partial \overline{s}}.
\end{aligned}$$

Evaluated at $\alpha = 1$, $\overline{s} = \frac{4-3\alpha}{\alpha}\mu = \mu$ and $\lambda = 1$, we have $\overline{p} = 2\mu$ and

$$\frac{\partial(\overline{s} - \overline{p} + \underline{p})}{\partial \overline{s}} = 1.$$

We conclude that for α close to 1 and $\overline{s}$ close to but smaller than $\frac{4-3\alpha}{\alpha}\mu$, we have $\mu + \overline{s} - \overline{p} < \mu - \underline{p}$. Thus, a firm k who charges $\overline{p}$ and deviates to A_k would strictly reduce its own demand, making this deviation not profitable. We conclude that firms who chose $(\overline{p}, \overline{s})$ strictly prefer to choose $A_k = 0$.

Now we show that deviations to larger prices do not increase profits. To do so, we prove the second statement that

$$\frac{\alpha}{4}(1 - G(p - \overline{s}))p \text{ is decreasing in } p \text{ for } p \geq \overline{p}.$$

Using that for $\overline{s}$ sufficiently close to $\frac{4-3\alpha}{\alpha}\mu$, $\overline{p}$ converges to $\mu + \overline{s}$ so that $\overline{p} - \overline{s} > 0$ and $p - \overline{s} > \underline{p}$, its derivative with respect to p shares the same sign as

$$1 - G(p - \overline{s}) - g(p - \overline{s})(p - \overline{s}) - \overline{s}g(p - \overline{s}).$$

Using the characterization in Proposition 1, it could be rewritten as

$$
\begin{aligned}
&1-G(p-\overline{s})-g(p-\overline{s})(p-\overline{s})-\overline{s}g(p-\overline{s}) \\
=&\frac{\alpha}{4}\frac{\overline{p}}{p-\overline{s}}+\frac{\alpha}{4}2(1-G(\mu))-\frac{\alpha}{4}\frac{\overline{p}}{p-\overline{s}}-\overline{s}\frac{\alpha}{4}\frac{\overline{p}}{(p-\overline{s})^2} \\
=&\frac{\alpha}{4}\left[2(1-G(\mu))-\frac{\overline{ps}}{(p-\overline{s})^2}\right]
\end{aligned}
\tag{B.18}
$$

Equation (B.18) is negative for all $p \geq \overline{p}$ if it is negative at $p = \mu + \overline{s}$. Using this and $(1 - G(\mu)) = \frac{\alpha}{2(2-\alpha)}\frac{\overline{p}}{\mu}$, we get the sufficient condition

$$\frac{\alpha}{4}\frac{\overline{p}}{v}\left[\frac{\alpha}{2-\alpha}-\frac{\overline{s}}{v}\right]<0.$$

In the limit of $\overline{s} = \frac{4-3\alpha}{\alpha}\mu$, the sufficient condition becomes

$$\frac{\alpha}{4}\frac{\overline{p}}{\mu}\left[\frac{\alpha}{2-\alpha}-\frac{4-3\alpha}{\alpha}\right]<0.$$

This sufficient condition holds if $\frac{\alpha}{2-\alpha}-\frac{4-3\alpha}{\alpha} < 0$, which is strictly negative for all $\alpha \in (0, 1)$. We conclude that for $\overline{s}$ close to but smaller than $\frac{4-3\alpha}{\alpha}\mu$, profits for deviations above $\overline{p}$ and setting $A_k = 1$ are decreasing in p. Overall, we conclude that for α close to 1 and $\overline{s}$ close to but smaller than $\frac{4-3\alpha}{\alpha}\mu$, firm k does not want to deviate to prices weakly above $\overline{p}$ and $A_k = 1$. This concludes the proof. □