DISCUSSION PAPER SERIES

DP17234

Distracted from Comparison: Product Design and Advertisement with Limited Attention

Johannes Johnen and Benson Tsz Kin Leung

INDUSTRIAL ORGANIZATION

ISSN 0265-8003

Distracted from Comparison: Product Design and Advertisement with Limited Attention

Johannes Johnen and Benson Tsz Kin Leung

Discussion Paper DP17234
Published 19 April 2022
Submitted 12 April 2022

Centre for Economic Policy Research
33 Great Sutton Street, London EC1V 0DX, UK
Tel: +44 (0)20 7183 8801
www.cepr.org

Distracted from Comparison: Product Design and Advertisement with Limited Attention

Abstract

We study how firms choose designs—of their products or product information—to divert consumers' limited attention away from price comparison or towards it. Firms choose de- signs to affect the dispersion of product match values and thereby how consumers allocate their limited attention. Consumers with limited attention trade off breadth and depths of search: they either study fewer products in detail to learn their match value, or superfi- cially browse and compare prices of more products. We highlight a novel distraction effect of designs. Firms combine larger prices with designs that disperse match values to dis- tract consumers from price-comparison. We show that more-detailed product information disperse match values and allows firms to distract consumers more effectively from price comparison. This way, interventions that allow firms to disclose more-detailed product in- formation weaken competition and decrease consumer surplus. In turn, interventions that make information coarser and more easily-available information—like energy-efficiency la- bels and front-package food labels like nutriscores—increases competition and consumer surplus. These findings connect evidence of various informational interventions in the context of pension funds, advertisements, and food labels.

JEL Classification: D83, L13, L15

Keywords: limited attention, Product design, information design, market competition, Distracting Consumers

Johannes Johnen - johannes.johnen@uclouvain.be
CORE/LIDAM, Université catholique de Louvain and CEPR

Benson Tsz Kin Leung - btkleung@hkbu.edu.hk
Hing Kong Baptist University

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

Johannes Johnen[†], *Benson Tsz Kin Leung*[‡]
April 12, 2022

Abstract

We study how firms choose designs—of their products or product information—to divert consumers' limited attention away from price comparison or towards it. Firms choose designs to affect the dispersion of product match values and thereby how consumers allocate their limited attention. Consumers with limited attention trade off breadth and depths of search: they either study fewer products in detail to learn their match value, or superficially browse and compare prices of more products. We highlight a novel distraction effect of designs. Firms combine larger prices with designs that disperse match values to distract consumers from price-comparison. We show that more-detailed product information disperse match values and allows firms to distract consumers more effectively from price comparison. This way, interventions that allow firms to disclose more-detailed product information weaken competition and decrease consumer surplus. In turn, interventions that make information coarser and more easily-available information—like energy-efficiency labels and front-package food labels like nutriscores—increases competition and consumer surplus. These findings connect evidence of various informational interventions in the context of pension funds, advertisements, and food labels.

Keywords: Limited Attention, Product Design, Information Design, Market Competition

JEL codes: D83, L13, L15

*We thank Marc Möller, Volker Nocke, Nicolas Schutz, and participants in various seminars and conferences for their valuable comments. Johnen thanks the Fédération Wallonie-Bruxelles for funding the Action de recherche concertée grant 19/24-101 'PROS-Eco', and the FNRS and FWO for the Excellence of Science project 30544469 'IWABE'. Johnen and Leung are co-first authors.

[†]CORE/LIDAM, Université catholique de louvain. Email: johannes.johnen@uclouvain.be

[‡]Hong Kong Baptist University. Email: btkleung@hkbu.edu.hk

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 new car could spend her time comparing prices of different sellers, or instead focus on fewer cars and think more carefully about which design, color or version she prefers 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. Sellers can also influence what consumers pay attention to, using product labels (Dubois et al. (2021); Crosetto et al. (2020)), advertisements (Dubois et al. (2018)), sales forces (Hastings et al. (2017)) 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 tradeoff between depths and breadth of search. We study firms who sell differentiated and use designs to influence more directly what consumers pay attention to. Second, building 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 they capture, for example, (i) that firms select product attributes about which consumers' opinions are more divided, or (ii) that firms make more precise product information available. For example, when food packages depict nutrients and ingredients, consumers can apply their preferences to these information, dispersing match values. Otherwise, consumers could not condition their choices on these information and match-values were more compressed.

In our basic 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 tradeoff 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 products. 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 capture that consumers differ in how they trade off product fit and prices, and consider two types of consumers. Bargain shoppers have the same match value for all products. They only care about prices and have sufficient attention to browse and compare all prices. 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 only study if i) the price they observe initially is not too large and—crucially—ii) match values are sufficiently dispersed. Thus, firms can use niche designs to increase the damage of a mismatch, i.e. a product value below price, to encourage 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 encourage value shoppers to study to avoid a mismatch. But when consumers study match values, they have less attention left to browse prices. This way, dispersed match values distract consumers from comparison shopping and make them less price sensitive.

The distraction effect explains why 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 tradeoff 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 the product a mismatch and not buy. So firms combine low price with mass-market designs, to ensure value shoppers browse and ignore other products. 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. 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 equilibrium, however, more-niche designs reinforce the distraction effect: consumers do less comparison shopping, which leads firms to raise prices and reduces consumer surplus. When niche designs result from product information, firms make too-detailed information available to distract consumers from price comparison: market outcomes feature a tradeoff between the quantity of information and competition.

To better understand that firms make excessive product information available, we show in an extension 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; because firms need limited attention to exploit the distraction effect.

The link between the quantity of information and competition has direct policy implications. Policymakers frequently intervene in markets via the information made available to consumers. 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: interventions that make more-detailed product information available can backfire and distract consumers from price comparison. Reversely, policies that provide coarser and easily-available product information encourage competition and benefit consumers.

These policy implications connect to recent debates about product labels such as energy-efficiency labels or front-package food labels (FPFLs) like nutriscores that were recently 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 indeed induce healthier food choices (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)) and sales force in Mexico's privatized pensions market (Hastings et al. (2017)) 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 Texas' electricity market offer cheaper and simpler contracts with a single rate that encourage comparison (Hortaçsu et al., 2017). Third, equilibrium prices closely resemble retailers' pricing patterns of regular prices and sales (Eden, 2018; Eichenbaum et al., 2011; Nakamura and Steinsson, 2008, 2011;

Pesendorfer, 2002), and in line with our prediction that firms who charge low prices want to encourage price comparison, Pesendorfer (2002) emphasizes that price reductions are regularly advertised.

We contribute to several existing literatures. We more beyond existing *search* models based on Wolinsky (1986), Anderson and Renault (2006), or Varian (1980) and models on *limited attention* (Anderson and De Palma (2012); Bordalo et al. (2016); Hefti (2018); Hefti and Liu (2020)), and study consumers who face a tradeoff between breadth and depth of search. In contrast to existing articles on *product design* (Johnson and Myatt (2006); Bar-Isaac et al. (2012)), we explore how firms use design to direct consumer attention. We nuance the classic view that *informative advertising* encourages competition (Bagwell (2007)) by showing how firms make product information available to distract consumers with limited attention from price comparison. We also complement work on advertising-induced *information overload*. In existing explanations (Anderson and De Palma, 2012; Hefti and Liu, 2020; Van Zandt, 2004), firms compete for consumer attention, which depletes attention not unlike a common-pool resource. In our setting, individual firms deliberately overload consumers with information to distract them from price comparison. Finally, we contribute to the literature on price *obfuscation* (Chioveanu and Zhou (2013); Carlin (2009); Piccione and Spiegler (2012)) by endogenizing how consumers allocate attention.

Section 2 introduces the basic model and discusses key assumptions. Section 3 characterizes equilibrium and the distraction effect. Section 4 discusses comparative statics and surplus. Section 5 explores policy implications. Section 6 connects to the related literature, and we conclude in Section 7. Robustness checks and proofs are in the Appendix and Web Appendix.[1]

2 The Basic Model

We consider two firms $k = 1, 2$ who sell a horizontally-differentiated product to a mass 1 of consumers. We denote the price of firm k by p_k. Firms have

[1]The Web Appendix is available at `https://sites.google.com/site/johannesjohneneconomist/research-working-papers`.

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 value shoppers, where $\alpha \in (0,1)$.[2] Bargain shoppers enjoy the same match value v from both products and see them as perfect substitutes. Depending on the context, bargain shoppers capture rather price-sensitive consumers who care more about getting a cheap deal than about match values, or consumers who have no knowledge or no access to information on the differentiation of products.

Value shoppers are sensitive to the products' prices *and* match values. Formally, a value shopper i who buys from firm k enjoys a match value v_{ik}. These match values v_{ik} are randomly distributed and independent across different value shoppers and the two firms, *i.e.*, $v_{ik} \perp v_{i'k}$ and $v_{ik} \perp v_{ik'}$ for $i \neq i'$ and $k \neq k'$. To simplify the illustration in the main text, we assume v_{ik} is distributed according to the following distribution, for all i and $k = 1, 2$,

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

Firms choose the design $s_k \in [0, \overline{s}]$, where $\overline{s}$ is exogenous. To ease exposition in the main text, we restrict attention to[3]

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

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.[4] A larger s_k rotates the C.D.F.

[2]Our results are robust when $\alpha \to 1$. Bargain shoppers help us rule out Diamond-paradox equilibria with monopoly prices because all consumers miscoordinate on studying.

[3]$\overline{s} > v$ implies that consumption with low match values can be inefficient and information on match values is potentially valuable. 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. We discuss in Web Appendices E.1 and E.2 how results extend to wider parameter ranges and continuous match-value distributions, respectively.

[4]We focus on the firms' strategic choice of s_k and assume all designs s_k cost the same.

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. Choosing s_k captures that firms can use product design or disclose product information to influence the dispersion of match values. We provide micro foundations for these and other interpretations in Web Appendix C and offer an intuitive discussion at the end of this section.

Limited Attention. We build on Heidhues et al. (2021) and model limited attention as a tradeoff between depth and breadth with the following sequential game. First, 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 and then decides whether to study to learn the match value v_{ik} of this product, or to browse the price p_{-k} of the other firm. To capture limited attention we impose that consumers cannot learn both the match value and the rival's price, and indeed face a tradeoff between depth and breadth. After browsing or studying, 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.

Timeline. We now formally outline the game. In the first period, each firm k chooses a design s_k and the price p_k. In the second period, consumers decide whether to study the match value of their initially-assigned firm or browse prices.[5] In equilibrium, consumers have correct beliefs about equilibrium prices. Finally, consumers make their purchasing decision. Figure 1 illustrates this timeline.

[5]The results are robust to various alternative timings. First, in the basic model firms have commitment power and cannot change the design ex-post. Firms, however, cannot benefit from ex-post changes in designs. In equilibrium, studying consumers expect maximum dispersion and only purchase with a large match-value, so any other designs with less dispersion could reduce demand of studying consumers. Second, we could also assume consumers do not observe designs but form rational beliefs conditioned on price. This will induce multiple equilibria like a Bertrand-type equilibrium where consumers believe $s_k = 0$ with probability 1. The equilibrium we present in the main text also exists. Third, firms might choose product designs before prices; in such a setting, firms prefer maximum dispersion to reinforce the distraction effect, but there is still price dispersion.

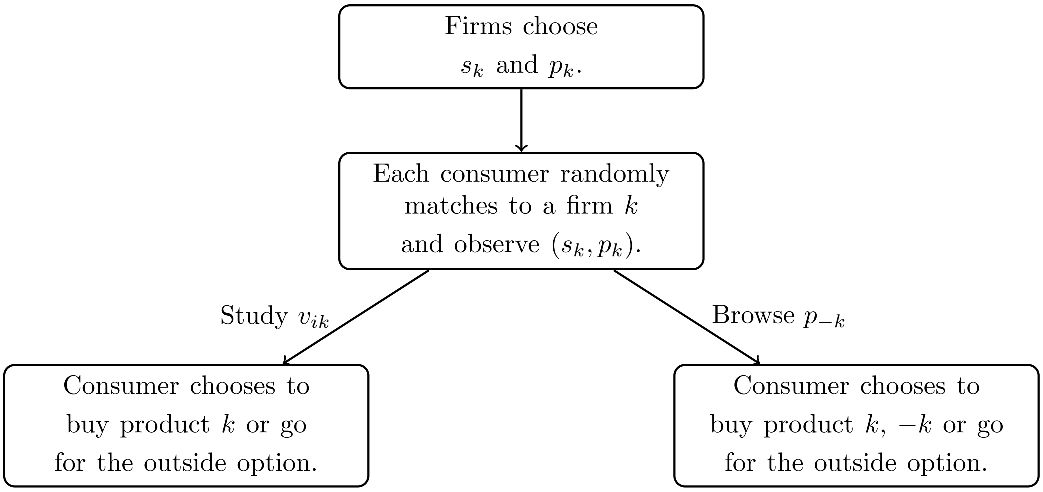

Figure 1: Timeline of the game

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.[6]

We make a mild equilibrium-selection assumption. When bargain shoppers are indifferent between browsing prices and studying match values, some arbitrarily small share browses prices. This rules out Diamond-paradox-type equilibria where all consumers study match values and all firms charge the monopoly price. We also assume that value shoppers study if they are indifferent.

2.1 Discussion of the Setup

The previous section introduces a simplified framework, and our results are robust to a wide range of extensions. We now briefly discuss the two key premises that we need for our main results, and then discuss some extensions and robustness checks.

The first key ingredient is that consumers have a limited capacity to compare options and face a tradeoff between breadth and depths of search. This

[6] As argued by Johnen and Ronayne (2021), symmetric equilibria are the unique robust equilibria in many models based on Rosenthal (1980) and Varian (1980) when an arbitrarily small share of consumers observes only two prices.

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 the environment to pay attention to. Evidence by Malmendier and Lee (2011) emphasizes the role of limited attention of eBay bidders, and Kling et al. (2012) find that consumers even ignore readily-available information. That people make strategic attentional decisions is documented by Bartoš et al. (2016), and in an experimental setting with multi-attribute products by Gabaix et al. (2006). Heidhues et al. (2021) argue that a tradeoff between breadths and depth arises if consumers have increasing marginal search costs. Supporting this argument, 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.

According to our second ingredient, firms can use designs to influence the dispersion of match values. Johnson and Myatt (2006) propose some microfoundations for such demand rotations. We discuss in detail how these and other microfoundations apply to our setting in Web Appendix C, and give an intuitive overview here.

First, when firms design products, they can *select product attributes* about which consumers' opinions are divided. For example, a car manufacturer can offer features that are somewhat ok for many consumers like conservative colors, comfortable and common interiors, or features rather targeted at niche audiences like flashy colors, or more sporty and extravagant interiors. Second, 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-detailed information about product features and characteristics allow consumers to apply their preferences on these information and disperse match values. With less-detailed or noisier information, consumers have fewer information they can apply their preferences too, which makes products more homogeneous and induce less-dispersed match values. For example, fund managers can decide how much details about their investment strategy they make available on their website or by their sales staff, and food manufacturers can choose how much information on ingredients, health and taste of their products they disclose. Third, when firms design a product or product information, they could *make quality-based features or taste-based features more salient*. For example, a cell-phone manufacturer could emphasize a phone's battery life or camera quality, or different colors and designs in which it is available.

The basic model is the simplest way to illustrate our results, but the main mechanism—the distraction effect—and our main results are robust to various extensions that we discuss carefully in Web Appendix E. First, the distraction effect is robust to a wider range of design parameters s. Second, it is robust when match values do not follow a binary but a continuous distribution, as is commonly assumed in many articles on consumer search.[7] Finally, the distraction effect is robust when there are more than two firms and consumers can search for more than one piece of information.[8]

3 Distract Consumers from Comparison

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, and then explore how firms choose prices and designs to influence consumers' attention.

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 less straightforward. Value shoppers trade off studying match values and browsing for bargains based on what benefits them most. They can browse prices to find a cheaper product, or study the match value of their initially-assigned product to avoid buying a mismatch where $v_{ik} < p_k$. The following lemma characterizes how value shoppers

[7]In contrast to the main text, rotations in this extension also affect the share of consumers with extreme tastes.

[8]Formally, we endogenize the outside option in the basic model as a continuation value of searching for more information, and show results hold qualitatively.

allocate their attention for a given price and design of their initially-assigned firm and their belief of the price distribution of the other firm.

Lemma 1. *Consider a value shopper who is initially assigned to firm k, learns $p_k \leq v + s_k$ and believes $p_{-k} \sim G_{-k}$. Then a larger s_k increases the value shopper's incentive to study match values.*[9] *Furthermore*

1. *If $s_k \geq v$, a value shopper browses prices if and only if p_k is bigger than some threshold $\tilde{p}$.*

2. *If $s_k < v$:*

   (a) *either she browses price for all p_k, or*

   (b) *there exists some $[\tilde{p}', \tilde{p}]$ such that she studies match values if and only if $p_k \in [\tilde{p}', \tilde{p}]$.*

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 three main insights for how firm 1 can influence how this consumer allocates her attention. First, the value shopper browses prices when the price she initially observes is sufficiently large. Intuitively, for any initially-observed and non-negative price $p_1 \in (v - s_1, v + s_1)$ the value shopper prefers buying over the outside option if and only if she has a good match. So she could benefit from studying 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 what De Clippel et al. (2014) call "competing for consumer inattention".

Second, and novel to this setting, firm 1 can choose a larger dispersion s_1 to encourage the consumer to study and thereby discourage comparison shopping. We call this the distraction effect: more dispersion makes mismatches more costly, which encourages the value shopper to study to avoid mismatches. But because the consumer has limited attention, she can no longer browse and compare alternative offers.

[9] More precisely, fixing p_k, G_{-k}, if the value shopper studies the match value for s_k, she studies match values for $s'_k > s_k$.

Third, firm 1 can choose sufficiently small dispersion s_1 to encourage browsing. Intuitively, lower dispersion makes mismatches less costly; and if $s_1 < v - p_1$ the value shopper no longer needs to worry about a mismatch at all. Thus, low dispersion can encourage the consumer to browse even for small prices. To summarize, firms can use large dispersion s_k to encourage studying, and small dispersion to encourage browsing.

We now use these insights to characterize the equilibrium behavior of consumers and the prices of firms.

Unsurprisingly, bargain shoppers always browse prices in equilibrium. These consumers do not benefit from studying match values, and because there is no mass point at the infimum price, bargain shoppers always have a chance to find a cheaper product and strictly prefer to browse prices.

In equilibrium, firms positively correlate larger prices with more-niche designs to influence how value shoppers allocate their attention: 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 and maximizes equilibrium profits.

In contrast, firms combine low prices with mass-market designs to encourage comparison shopping and make value shoppers less skeptical towards product fit. This has two reasons. First, studying can reduce demand: with large dispersion $\overline{s}$, value shoppers who draw a mismatch $v_{ik} = v - \overline{s} < 0$ 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. For both reasons, firms combine low prices with mass-market designs to encourage comparison shopping and thereby increases demand from value shoppers.

To summarize, firms combine large prices with niche designs to distract consumers from price comparison, and low prices with mass-market designs to encourage price comparison (see Figure 2).

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. But firms have an incentive to undercut prices to compete for bargain shoppers. If, however, 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).[10]

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* $[\underline{p}, v] \cup \{\overline{p}\}$*, where* $\overline{p} \in (v, v + \overline{s})$*. There are no gaps and mass points on* $[\underline{p}, v]$*. Firms mix* $(p, s(p))$*, where* $s(p)$ *follows:*

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

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 study match values at high price* $\overline{p}$ *and browse for low prices* $p \in [\underline{p}, v]$*; bargain shoppers browse prices with probability one.*

Given parameters α, v and $\overline{s}$, all symmetric equilibria feature the same profits, price distribution, and—as shown in Equation (2)—a positive correlation between prices and the dispersion of match values: firms combine high prices $\overline{p}$ with a niche design ($\overline{s}$), while they couple low prices with a more mass-market design (low-enough s, e.g., $s = 0$).[11]

Unlike in many classic search models based on Varian (1980), the largest price $\overline{p}$ is endogenously determined in equilibrium and results from the firms'

[10] Note that one could also induce 'stable price dispersion' with asymmetric pure-strategy equilibria in our setting by adapting the framework in the spirit of Myatt and Ronayne (2019): in the first stage, firms can charge list prices, which they can undercut by offering discounts in the second stage.

[11] Because s only needs to be low enough to induce value shoppers to browse, these low s are not uniquely pinned down in equilibrium. In many applications it is natural for firms to choose $s = 0$ for $p \leq v$, for example if there was a very small cost of choosing a more specialized niche design.

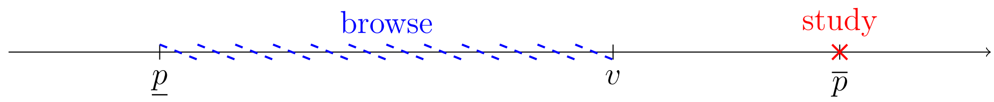

Figure 2: The support of equilibrium prices. Value shoppers study match value for the price $\overline{p}$ indicated by the red cross and browse prices in blue shaded area with dotted lines.

design choice to distract value shoppers from price comparison.[12] Also unlike in such models, there is a gap in the price distribution with no probability mass in $(v, \overline{p})$. The reason is that designs affect how consumers search and perceive products: firms encourage comparison shopping for lower prices, but discourage comparison shopping for large prices. This leads to a mass point and less price dispersion for large prices.

The distraction effect helps connect evidence related to pricing, product design and advertisement. First, Dubois et al. (2018) and Hastings et al. (2017) find that exposure to advertisements and sales forces allows firms to charge larger prices.[13] 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

[12]More precisely, the existing literature on fixed-sample search models (Rosenthal (1980), Varian (1980), Armstrong and Vickers (2018), etc.) mostly takes as given how many consumers are captive. In our setting, however, firms choose design to influence the share of captive consumers and which maximal price they can charge in equilibrium while keeping consumers captive.

[13]Dubois et al. (2018) study the UK market for chips where manufacturers typically make many product varieties available. In line with our interpretation from Section 2.1 that firms induce match-value dispersion by emphasizing taste-based features, the advertisement ban makes it harder to emphasize taste-based features like the varieties of chips, putting quality-based features like nutritional value more into focus and effectively reducing dispersion of taste-based features. Hastings et al. (2017) study Mexico's privatized pension market. We interpret exposure to sales force as allowing firms to make more-detailed information available, i.e. as an increase in $\overline{s}$. In line with our mechanism, the authors suggest that 'competition on advertising and nonprice attributes substituted for competition on price', and estimate that eliminating the effect of sales force would reduce total fees by 17%.

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.[14] Third, because design influences how consumers search and perceive products, large prices are less dispersed than smaller prices below v ($< \overline{p}$). 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) emphasize 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.

4 Surplus Analysis

We now explore how the distraction effect impacts producer- and consumer surplus. Before doing comparative statics, we discuss how the maximal price $\overline{p}$ and the share of studying value shoppers influence the equilibrium price distribution G, profits, and consumer surplus.

Lemma 2. *The probability mass on the maximal price $\overline{p}$ equals the share of studying value shoppers and is*

$$\lambda = \frac{\alpha}{2(2-\alpha)} \frac{\overline{p}}{v}. \tag{3}$$

Equilibrium price increases in the sense of F.O.S.D. in $\overline{p}$. Firms' profits increase in $\overline{p}$ and λ. The surplus of value shoppers and bargain shoppers decrease in $\overline{p}$ and λ.

[14] The incumbent's price scheme and price level are regulated.

We know from Proposition 1 that value shoppers study if they initially see the price $\overline{p}$, and browse for prices in $[\underline{p}, v]$. Thus, the probability mass λ on $\overline{p}$ is also the probability that value shoppers study; and because studying value shoppers are the firms' profit base, λ is inversely related to the degree of competition in the market.

Lemma 2 describes how the equilibrium price distribution changes with $\overline{p}$ and λ. First, λ and $\overline{p}$ are both determined in equilibrium, and we see from (3) that they are positively related: more studying value shoppers go hand-in-hand with a larger maximum price in equilibrium. Second, if firms can charge a larger maximal price $\overline{p}$, the entire price distribution shifts upwards. The reason is the distraction effect: if consumers do less comparison shopping, firms charge larger prices.

The lemma also describes how λ and $\overline{p}$ connect to profits and consumer surplus. If more value-shoppers are distracted from comparison shopping and study in equilibrium, fewer consumers compare prices and firms compete less intensely, which also affects the browsing bargain shoppers. Thus, a larger λ indicates larger profits and—even though more consumers study and avoid a mismatch—a lower consumer surplus.

4.1 Too much Information?

We now explore how changes in $\overline{s}$ affect consumer surplus and firms' profits.[15] As we outline in Section 2.1, an increase in $\overline{s}$ means that firms can use more niche designs. This can occur due to an innovation in production- or information technology, or changes in the regulation of products or advertisements. For example, changes in $\overline{s}$ can reflect new information-disclosure requirements about product risks like nutriscores or energy-efficiency labels, or bans of certain types of advertisements. A larger $\overline{s}$ can also reflect that advances of information technology make it easier for firms to disclose product information.

The following proposition states that the proportion of captive value shoppers λ changes in $\overline{s}$ and v.

[15] In Web Appendix D, we also present comparative statics with respect to v and α.

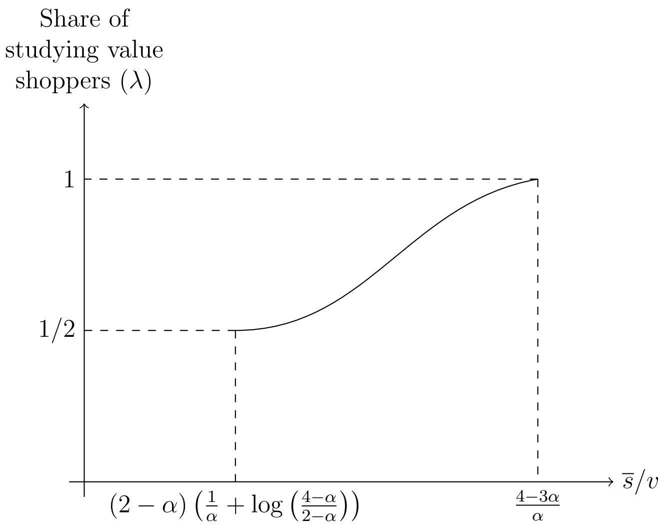

Figure 3: The share of studying value shoppers on $\overline{s}/v$.

Proposition 2. *The equilibrium share of studying value shoppers λ is increasing in $\overline{s}/v$.*

Figure 3 illustrates this result. Proposition 2 states that a larger $\overline{s}$ allows firms to distract consumers more effectively, leading firms to charge $\overline{p}$ more often. The reason is the following: we know from Proposition 1 that firms charge $\overline{s}$ to distract value shoppers from price comparison and to maximize $\overline{p}$. By Lemma 2, a larger $\overline{p}$ also shifts the entire equilibrium price distribution upwards, further reducing incentives to browse. Thus, a larger $\overline{s}$ leads to less price comparison and larger prices.

Proposition 2 also emphasizes that the relative dispersion $\overline{s}/v$ is key to characterize the distraction effect. Intuitively, a larger v makes it safe to buy a product without studying, which makes browsing and price comparison more attractive.

We now move on to study how changes in $\overline{s}$ affect equilibrium profits and consumer surplus, starting with profits.

Corollary 1. *Firms' equilibrium profit is increasing in $\overline{s}$.*

The reason for this effect is straightforward: more niche designs allow firms to better distract value shoppers from price comparison. This increases prices and profits in equilibrium.[16]

We now investigate how more-niche designs impact consumer surplus. Fixing prices and consumer behavior, more dispersion increases the surplus of studying value shoppers and keeps surplus of browsing consumers unaffected. This captures the intuition that more-precise information about match values lead to better matches for consumers and suggests that more information on match values could benefit consumers. By Proposition 2, however, more niche designs also lead to larger prices. The following corollary works out that the second effect dominates.

Corollary 2. *The surplus of value shoppers and bargain shoppers decreases in $\overline{s}$.*

The key reason for why more-dispersed match values reduce consumer surplus is the distraction effect. To work this out more precisely, we study a benchmark in Appendix A.1 where all consumers are value shoppers and have full attention. 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 endogenous attention, and only features the classic differentiation effect on preferences: when firm 1 charges its largest equilibrium price, it only sells to value shoppers who draw a large match value only of firm 1. Firm 1 is effectively the monopolist for these consumers. A larger $\overline{s}$ creates additional value for value shoppers who draw a large match value from firm 1, 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 a larger $\overline{s}$ does not reduce consumer surplus. This benchmark captures the argument by Nelson (1974) that advertising informs consumers about their match values with products and creates benefits to consumers.

With limited attention, however, a larger $\overline{s}$ also changes shopping behavior. In particular, more dispersion distracts value shoppers from price

[16]Note that increasing v has ambiguous effects on profits. First, it increases the valuation of studying value shoppers who find the product a good match and thus improves profits. Second, it makes price comparison more attractive for value shoppers and thus decreases the profit base. The overall effect is ambiguous.

comparison, which increases the share of captive consumers and weakens competition. By weakening competition, the distraction effect induces price increases beyond the additional value generated through a larger $\overline{s}$ and therefore reduces consumer surplus.

When we interpret design as resulting from product information, the result offers a novel channel through which firms disclose product information and thereby harm consumers. More-detailed product information helps consumers make better choices about their match values. Fixing how consumers allocate attention, these information 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 captured consumers. This way, firms who help consumers find a better product match might also harm the consumers who seek this information. Indeed, in equilibrium 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.

Crucially, while firms make excessive information available, our results do not suggest that firms want to make information easily available or understandable. In fact, firms want to obfuscate information. To see this, take our extension in Appendix A.2 where firms can either make their design easily understandable or obfuscate it.[17] If a firm's design is easily understandable, value shoppers initially assigned to this firm understand their match value without using up attention. But if firms obfuscate design, value shoppers have to use attention to study their match value just like in the main 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 charge $(\overline{p}, \overline{s})$ in equilibrium. If this firm, when charging $(\overline{p}, \overline{s})$, would make information easily understandable, it would encourage comparison shopping and lose consumers. Indeed, firms can only successfully distract consumers from comparison shopping if

[17]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, they find personalized information about health insurance plans improves choice quality.

their attention is scarce. 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)).

5 Policy Implications

We now apply the insights from the previous sections to discuss how interventions could promote or discourage competition.

Standardization of Product Features. Proposition 1 and Corollary 2 state that firms 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.

In classic models of product differentiation with full attention (e.g. Ronnen (1991) and Veall (1985)), standards work by affecting consumer preferences: standards make products less desirable for some consumers who would have preferred a different standard, but also make products more homogeneous and thereby encourage competition. Our distraction affect highlights a novel attention-based channel through which standards can benefit consumers: standards reduce dispersion of product match values and thereby encourage consumers to use their limited attention to compare products, which encourages competition.

Product Information. Our previous results help understand which information-based interventions benefit consumers. As we discussed in Section 2.1, more-dispersed match values capture that firms disclose more-detailed information about products. Thus, Proposition 1 and Corollary 2, imply that coarser information, i.e. a lower $\overline{s}$, increase surplus of bargain shoppers and value shoppers. Coarser information encourage comparison shopping, inducing lower prices and larger consumer surplus. Additionally, as we discussed in the previous section, 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. These findings help understand when information-based interventions benefit consumers: Interventions that push for coarser and easily-available product information encourage comparison shopping and competition. Reversely, interventions that make more-detailed product-information available can backfire, because they distract consumers from comparison shopping.

These predictions are in line with the aforementioned evidence that exposure to advertisement and sales forces makes consumers less price sensitive (see Hastings et al. (2017) and Dubois et al. (2018)). We suggest an attention-based mechanism to explain this evidence: more exposure distracts consumers from price comparison, making consumers less price sensitive. This evidence, however, is also in line with other explanations.[18] But evidence on product labels works out more precisely that attentional refocusing—and therefore our distraction effect—is part of the picture.

Product labels like energy-efficiency labels for electronic appliances and front-package food labels (FPFL) like the nutriscore in the EU aggregate information on energy use or health of food in a single statistic and therefore make information coarser. Because labels are often printed on the front of a package, they also make information more easily available.[19]

Evidence from labs and the field suggests 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)).[20] But—in line with our mechanism—evidence also suggests that FPFLs encourage comparison shop-

[18]For example exposure could have persuaded consumers of a brand, or could have changed consumers preferences.

[19]Our setting also captures that information help consumers learn about quality features like food health: a consumer expects the average quality v; and product information like food labels can reveal if the product is better or worse than expected.

[20]See Ikonen et al. (2020) for a metastudy on multiple food labels.

ping by refocusing consumer attention: Crosetto et al. (2020) and Dubois et al. (2021) report that consumers refocus attention away from nutrient tables towards FPFLs. Similarly, Barahona et al. (2021) show that labels affect consumers' beliefs about product health and induce consumers to switch from high-sugar to cheaper low-sugar cereals. Finally, lab- (Crosetto et al., 2020) and field-evidence (Dubois et al., 2021; Kiesel and Villas-Boas, 2013) finds that coarser labels with more-aggregated information like the nutriscore more effectively induce healthier food-choices than labels with disaggregated and detailed information, suggesting—as we predict—that coarser information encourage more comparison shopping.

From a classic economic perspective without limited attention it might not be obvious why coarser and less-detailed information improves 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, thereby benefiting other consumers but also—in equilibrium—themselves.

Our equilibrium predictions are also in line with anecdotal evidence on nutriscores. First, Proposition 1 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 for their own brands and large food producers like Danone and Iglo.[21] Second, in line with our prediction that more-detailed information increase industry profits, the industry

[21] In Belgium, nutriscores were recommended by the government in 2018 and applied by Delhaize and Colruyt on their own-brand products; see http://www.flanderstoday.eu/nutri-score-label-appear-supermarket-products. In France they were applied by Leclerc, Auchan, Intermarché, Casino, Carrefour and Système U for their own brands. https://www.mangerbouger.fr/Manger-mieux/Comment-manger-mieux/Comment-comprendre-les-informations-nutritionnelles/Qu-est-ce-que-le-Nutri-Score. 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 23. October 2020.

lobby opposed nutriscores by suggesting alternatives with more-detailed information (Julia et al. (2018a,b)). As a case in point, 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.[22]

In the EU, companies use nutriscores on a voluntary basis. Our results suggest that compulsory nutriscores would not just help consumers identify healthy food, but also encourage competition by pushing also sellers of niche products to compete more fiercely.

6 Related Theoretical Literature

Consumer search and limited attention. Many existing search models based on Wolinsky (1986) and Anderson and Renault (1999) feature prices and match values, but existing search models commonly assume that consumers who search a product learn both its price and match value. 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.[23] These articlles do not model limited attention as a tradeoff between breadth and depths of consumer search, which is why they do not capture a mechanism like our distraction effect. We model consumers' limited attention based on Heidhues et al. (2021) who investigate how consumers allocate attention between a product's basic- and secondary fees. But firms in our setting can use designs to more-directly influence what consumers pay attention to, which allows us to identify the novel distraction effect.

Competition with horizontally-differentiated products. Accord-

[22]On Nestlé introducing the nutriscore, see `https://www.foodbev.com/news/nestle-to-introduce-nutri-score-nutrition-labelling-in-europe/`, accessed on 23. October 2020.

[23]Matveenko and Starkov (2021) study how a monopolist targets information at rationally inattentive consumers. The monopolist targets ads to reduce consumers' value from acquiring their own information. But they consider exogenous prices.

ing to the classic view on competition with horizontally-differentiated products, a firm differentiates its product to compete less fiercely for the consumers who prefer this product. Our distraction effect works by affecting how consumers allocate attention and differs from this perspective. First, firms use design to redirect consumers' attention away from price comparison, making consumers less price sensitive. By redirecting attention away from comparison shopping—and in contrast to many classic models on horizontal product differentiation—firms *increase* the share of captured consumers.[24] Second, with horizontal differentiation and full attention, firms choose maximum dispersion of match values, while with limited attention we find positive correlation between prices and match-value dispersion. Third, our notion of design applies not just to product design, but also to information disclosure about products. This is why models with horizontally-differentiated products are not in line with aforementioned evidence that food labels like nutriscores affect how consumers allocate attention.

We model **product design** based on Johnson and Myatt (2006), who study monopolists. Monopolists choose extreme designs, i.e. niche or mass-market designs. Monopolists prefer a niche design if and only if, at an optimal price for a given demand, more dispersion increases demand. Bar-Isaac et al. (2012) investigate product design in a sequential search model. Because consumers perfectly understand products they searched, firms choose a broad or niche design—not unlike in the monopoly setting of Johnson and Myatt (2006)—to increase demand from consumers who searched it. In contrast to both articles, in our setting firms choose a product design to directly influence how consumers allocate their limited attention.

Competition and information disclosure. Classic models on informative advertising as summarized in Bagwell (2007) emphasize that informative advertising makes consumers aware of alternative offers and their prices and thereby encourages entry and competition.[25] More recently, some

[24] One example of such a classic model is the Hotelling model where more differentiation reduces a firm's demand. Another one is the current model with full attention that we discuss in Appendix A.1. We show that with full attention, a more-niche design does not change the share of captive consumers but merely increases their match value.

[25] An exception is Meurer and Stahl II (1994), where firms have negatively correlated

existing models explore how firms disclose information before competing in prices (Anderson and Renault (2009), Leung (2019)). But these articles do not consider limited attention, which is why our main mechanism is conceptually different: when firms in our setting disclose information, they do not only affect what consumers know, but also what they focus on.

The literature on **advance purchases** explores how firms price discriminate between consumers who can buy early, or later to better learn their preferences (Möller and Watanabe (2010); Möller and Watanabe (2016); Nocke et al. (2011)). Also studying allows consumers to learn their preferences. But we do not consider price discrimination, and firms can also designs to affect what consumers learn before they purchase.

We complement existing explanation for advertising-induced **information overload**. 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.

Obfuscation. Our work also complements existing work on price obfuscation (e.g., Chioveanu and Zhou (2013); Ellison and Wolitzky (2012); Gu and Wenzel (2014); Carlin (2009); Piccione and Spiegler (2012)), where firms use price frames to influence the ability of consumers to compare prices of homogeneous products. We differ from these articles in at least two ways. First, we do not study price frames, but focus on how firms design and obfuscate horizontally-differentiated product features. Second, the literature on obfuscation mostly fixes consumer search behavior exogenously and focuses on firms' responses to policies and competition. Because we endogenize how consumers allocate their attention, we can work out novel insights on how information-based policies like product labels can encourage consumers to reallocate their attention towards price comparison.

---

match values so that information turns firms into monopolists over some consumers.

7 Conclusion

We investigate how firms design products and product information to influence how consumers allocate their attention away from or towards product comparison. The equilibrium features a positive correlation between prices and the dispersion of match values: cheap products have a mass-market design and expensive products a niche design.

We model limited attention by focusing on the intensive search margin, i.e. on how consumers allocate a given amount of attention. Because firms might choose a large dispersion of match values, one might think consumers should also have large incentive to search more on the extensive margin. This intuition is misleading for two reasons. First, firms choose dispersed match values to set larger prices throughout the market. Indeed, through this price effect, more dispersion reduces consumer surplus, suggesting more dispersed match values might reduce benefits from more search. Second, we study an extension where consumers can search in the extensive margin, and show that our results from the main text are qualitatively robust.

Work in recent years by the CMA in the UK on loyalty penalties suggests that regulators are increasingly concerned about captive consumers who stay with one provider for many years without comparing prices.[26] Our paper is one of the first to explore how firms use non-price product features to manipulate consumer attention in a way to increase the share of captive consumers who no longer compare alternative offers. Our results help understand which information-based policies can help to activate such captive consumers to do more comparison shopping.

We believe, however, that more research should be done in this direction. For example, how can firms use targeted offers and designs to affect how consumers allocate their attention, or to what extent do intermediaries like price-comparison websites want to coordinate designs of multiple products when designing their marketplace? We leave this and other questions for future research.

[26] See https://www.gov.uk/cma-cases/loyalty-penalty-super-complaint for an overview. Accessed 30. June 2021.

References

Alexandrov, Alexei and Sergei Koulayev (2018) "No Shopping in the US Mortgage Market: Direct and Strategic Effects of Providing Information," *Consumer Financial Protection Bureau Office of Research Working Paper*, No. 2017-01.

Anderson, Simon P and André De Palma (2012) "Competition for Attention in the Information (Overload) Age," *The RAND Journal of Economics*, Vol. 43, No. 1, pp. 1–25.

Anderson, Simon P and Regis Renault (1999) "Pricing, Product Diversity, and Search Costs: A Bertrand-Chamberlin-Diamond model," *The RAND Journal of Economics*, pp. 719–735.

Anderson, Simon P. and Régis Renault (2006) "Advertising Content," *The American Economic Review*, Vol. 96, No. 1, pp. 93–113.

Anderson, Simon P and Régis Renault (2009) "Comparative Advertising: Disclosing Horizontal Match Information," *The RAND Journal of Economics*, Vol. 40, No. 3, pp. 558–581.

Armstrong, Mark and John Vickers (2018) "Patterns of Competition with Captive Customers," *Working Paper*.

Bagwell, Kyle (2007) "The Economic Analysis of Advertising," *Handbook of Industrial Organization*, Vol. 3, pp. 1701–1844.

Bar-Isaac, Heski, Guillermo Caruana, and Vicente Cuñat (2012) "Search, Design, and Market Structure," *American Economic Review*, Vol. 102, No. 2, pp. 1140–60.

Barahona, Nano, Cristóbal Otero, Sebastián Otero, and Joshua Kim (2021) "Equilibrium Effects of Food Labeling Policies," *Working Paper*.

Bartoš, Vojtěch, Michal Bauer, Julie Chytilová, and Filip Matějka (2016) "Attention Discrimination: Theory and Field Experiments with Monitoring Information Acquisition," *American Economic Review*, Vol. 106, No. 6, pp. 1437–75.

Bordalo, Pedro, Nicola Gennaioli, and Andrei Shleifer (2016) "Competition for Attention," *The Review of Economic Studies*, Vol. 83, No. 2, pp. 481–513.

Carlin, Bruce I (2009) "Strategic Price Complexity in Retail Financial Markets," *Journal of Financial Economics*, Vol. 91, No. 3, pp. 278–287.

Chantal, Julia, Serge Hercberg, World Health Organization et al. (2017) "Development of a New Front-of-Pack Nutrition Label in France: The Five-Colour Nutri-Score," *Public Health Panorama*, Vol. 3, No. 04, pp. 712–725.

Chioveanu, Ioana and Jidong Zhou (2013) "Price Competition with Consumer Confusion," *Management Science*, Vol. 59, No. 11, pp. 2450–2469.

Consumer Financial Protection Bureau (2015) "Consumers' Mortgage Shopping Experience,"Technical report, Consumer Financial Protection Bureau, https://files.consumerfinance.gov/f/201501_cfpb_consumers-mortgage-shopping-experience.pdf.

Crosetto, Paolo, Anne Lacroix, Laurent Muller, and Bernard Ruffieux (2020) "Nutritional and Economic Impact of Five Alternative Front-of-Pack Nutritional Labels: Experimental Evidence," *European Review of Agricultural Economics*, Vol. 47, No. 2, pp. 785–818.

De Bauw, Michiel, Christophe Matthys, Veerle Poppe, and Liesbet Vranken (2021) "A Combined Nutri-Score and 'Eco-Score'Approach for more Nutritious and more Environmentally Friendly Food Choices? Evidence from a Belgian Consumer Experiment.."

De Clippel, Geoffroy, Kfir Eliaz, and Kareen Rozen (2014) "Competing for Consumer Inattention," *Journal of Political Economy*, Vol. 122, No. 6, pp. 1203–1234.

De Los Santos, Babur, Ali Hortacsu, and Matthijs R. Wildenbeest (2012) "Testing Models of Consumer Search Using Data on Web Browsing and Purchasing Behavior," *American Economic Review*, Vol. 102, No. 6, pp. 2955–80.

De Temmerman, Joyce, Eva Heeremans, Hendrik Slabbinck, and Iris Vermeir (2021) "The Impact of the Nutri-Score Nutrition Label on Perceived Healthiness and Purchase Intentions," *Appetite*, Vol. 157, p. 104995.

Dubois, Pierre, Paulo Albuquerque, Olivier Allais, Céline Bonnet, Patrice Bertail, Pierre Combris, Saadi Lahlou, Natalie Rigal, Bernard Ruffieux, and Pierre Chandon (2021) "Effects of Front-of-Pack Labels on the Nutritional Quality of Supermarket Food Purchases: Evidence from a Large-Scale Randomized Controlled Trial," *Journal of the Academy of Marketing Science*, Vol. 49, No. 1, pp. 119–138.

Dubois, Pierre, Rachel Griffith, and Martin O'Connell (2018) "The Effects of Banning Advertising in Junk Food Markets," *The Review of Economic Studies*, Vol. 85, No. 1, pp. 396–436.

Eden, Benjamin (2018) "Price Dispersion and Demand Uncertainty: Evidence From U.S. Scanner Data," *International Economic Review*, Vol. 59, No. 3, pp. 1035–1075, DOI: 10.1111/iere.12296.

Egnell, Manon, Isabelle Boutron, Sandrine Péneau, Pauline Ducrot, Mathilde Touvier, Pilar Galan, Camille Buscail, Raphaël Porcher, Philippe Ravaud, Serge Hercberg et al. (2019) "Front-of-Pack Labeling and the Nutritional Quality of Students' Food Purchases: A 3-Arm Randomized Controlled Trial," *American Journal of Public Health*, Vol. 109, No. 8, pp. 1122–1129.

Eichenbaum, Martin, Nir Jaimovich, and Sergio Rebelo (2011) "Reference Prices, Costs, and Nominal Rigidities," *American Economic Review*, Vol. 101, No. 1, pp. 234–62.

Ellison, Glenn and Alexander Wolitzky (2012) "A Search Cost Model of Obfuscation," *The RAND Journal of Economics*, Vol. 43, No. 3, pp. 417–441.

Gabaix, Xavier, David Laibson, Guillermo Moloche, and Stephen Weinberg (2006) "Costly Information Acquisition: Experimental Analysis of a Boundedly Rational Model," *American Economic Review*, Vol. 96, No. 4, pp. 1043–1068.

Gu, Yiquan and Tobias Wenzel (2014) "Strategic Obfuscation and Consumer Protection Policy," *The Journal of Industrial Economics*, Vol. 62, No. 4, pp. 632–660.

Hagmann, Désirée and Michael Siegrist (2020) "Nutri-Score, Multiple Traffic Light and Incomplete Nutrition Labelling on Food Packages: Effects on Consumers' Accuracy in Identifying Healthier Snack Options," *Food Quality and Preference*, Vol. 83, p. 103894.

Handel, Benjamin and Joshua Schwartzstein (2018) "Frictions or Mental Gaps: What's Behind the Information We (Don't) Use and When Do We Care?" *Journal of Economic Perspectives*, Vol. 32, No. 1, pp. 155–78.

Hastings, Justine, Ali Hortaçsu, and Chad Syverson (2017) "Sales Force and Competition in Financial Product Markets: The Case of Mexico's Social Security Privatization," *Econometrica*, Vol. 85, No. 6, pp. 1723–1761.

Hefti, Andreas (2018) "Limited Attention, Competition and Welfare," *Journal of Economic Theory*, Vol. 178, pp. 318–359.

Hefti, Andreas and Shuo Liu (2020) "Targeted Information and Limited Attention," *The RAND Journal of Economics*, Vol. 51, No. 2, pp. 402–420.

Heidhues, Paul, Johannes Johnen, and Botond Kőszegi (2021) "Browsing versus Studying: A Pro-Market Case for Regulation," *The Review of Economic Studies*, Vol. 88, No. 2, pp. 708–729.

Heiss, Florian, Daniel McFadden, Joachim Winter, Amelie Wuppermann, and Bo Zhou (2019) "Inattention and Switching Costs as Sources of Inertia in Medicare Part D."

Honka, Elisabeth and Pradeep Chintagunta (2017) "Simultaneous or Sequential? Search Strategies in the U.S. Auto Insurance Industry," *Marketing Science*, Vol. 36, No. 1, pp. 21–42.

Hortaçsu, Ali, Seyed Ali Madanizadeh, and Steven L Puller (2017) "Power to Choose? An Analysis of Consumer Inertia in the Residential Electricity Market," *American Economic Journal: Economic Policy*, Vol. 9, No. 4, pp. 192–226.

Ikonen, Iina, Francesca Sotgiu, Aylin Aydinli, and Peeter WJ Verlegh (2020) "Consumer Effects of Front-of-Package Nutrition Labeling: An Interdisciplinary Meta-Analysis," *Journal of the Academy of Marketing Science*, Vol. 48, No. 3, pp. 360–383.

Johnen, Johannes and David Ronayne (2021) "The Only Dance in Town: Unique Equilibrium in a Generalized Model of Price Competition," *The Journal of Industrial Economics*, Vol. 69, No. 3, pp. 595–614.

Johnson, Justin P. and David P. Myatt (2006) "On the Simple Economics of Advertising, Marketing, and Product Design," *American Economic Review*, Vol. 96, No. 3, pp. 756–784.

Julia, C, S Hercberg et al. (2018b) "Big Food's Opposition to the French Nutri-Score Front-of-Pack Labeling Warrants a Global Reaction," *American Journal of Public Health*, Vol. 108, No. 3, pp. 318–320.

Julia, Chantal, Fabrice Etilé, and Serge Hercberg (2018a) "Front-of-Pack Nutri-Score Labelling in France: An Evidence-Based Policy," *The Lancet Public Health*, Vol. 3, DOI: 10.1016/S2468-2667(18)30009-4.

Kaufmann, Cornel, Tobias Müller, Andreas Hefti, and Stefan Boes (2018) "Does Personalized Information Improve Health Plan Choices When Individuals Are Distracted?" *Journal of Economic Behavior & Organization*, Vol. 149, pp. 197–214.

Kiesel, Kristin and Sofia B Villas-Boas (2013) "Can Information Costs Affect Consumer Choice? Nutritional Labels in a Supermarket Experiment," *International Journal of Industrial Organization*, Vol. 31, No. 2, pp. 153–163.

Kling, Jeffrey R, Sendhil Mullainathan, Eldar Shafir, Lee C Vermeulen, and Marian V Wrobel (2012) "Comparison Friction: Experimental Evidence from Medicare Drug Plans," *The Quarterly Journal of Economics*, Vol. 127, No. 1, pp. 199–235.

Leung, Benson Tsz Kin (2019) "Information Disclosure in a Duopoly," *Working Paper*.

Malmendier, Ulrike and Young Han Lee (2011) "The Bidder's Curse," *American Economic Review*, Vol. 101, No. 2, pp. 749–87.

Maskin, Eric and Jean Tirole (1988a) "A Theory of Dynamic Oligopoly , I : Overview and Quantity Competition with Large Fixed Costs Author (s): Eric Maskin and Jean Tirole Published by : The Econometric Society Stable URL : http://www.jstor.org/stable/1911700," *Econometrica*, Vol. 56, No. 3, pp. 549–569.

——— (1988b) "A Theory of Dynamic Oligopoly, II: Price Competition, Kinked Demand Curves, and Edgeworth Cycles," *Econometrica*, Vol. 56, No. 3, p. 571, DOI: 10.2307/1911701.

Matveenko, Andrei and Egor Starkov (2021) "Sparking Curiosity or Tipping the Scales? Targeted Advertising to Rationally Inattentive Consumers," *Working Paper*.

Meurer, Michael and Dale O Stahl II (1994) "Informative Advertising and Product Match," *International Journal of Industrial Organization*, Vol. 12, No. 1, pp. 1–19.

Möller, Marc and Makoto Watanabe (2010) "Advance Purchase Discounts Versus Cllearance Sales," *The Economic Journal*, Vol. 120, No. 547, pp. 1125–1148.

Möller, Marc and Makoto Watanabe (2016) "Competition in the Presence of Individual Demand Uncertainty," *RAND Journal of Economics*, Vol. 47, No. 2, pp. 273–292, DOI: 10.1111/1756-2171.12127.

Mullainathan, Sendhil and Eldar Shafir (2013) *Scarcity: Why Having too Little Means so much*: Macmillan.

Myatt, David P and David Ronayne (2019) "A Theory of Stable Price Dispersion," *Working Paper*, pp. 1–40, URL: `https://www.economics.ox.ac.uk/materials/working_papers/5068/a-theory-of-stable-price-dispersion-873.pdf`.

Nakamura, Emi and Jón Steinsson (2008) "Five Facts about Prices: A Reevaluation of Menu Cost Models," *The Quarterly Journal of Economics*, Vol. 123, No. 4, pp. 1415–1464.

——— (2011) "Price Setting in Forward-Looking Customer Markets," *Journal of Monetary Economics*, Vol. 58, No. 3, pp. 220–233.

Nelson, Phillip (1974) "Advertising as Information," *Journal of Political Economy*, Vol. 82, No. 4, pp. 729–754.

Nocke, Volker, Martin Peitz, and Frank Rosar (2011) "Advance-Purchase Discounts as a Price Discrimination Device," *Journal of Economic Theory*, Vol. 146, No. 1, pp. 141–162, URL: `http://dx.doi.org/10.1016/j.jet.2010.07.008`, DOI: 10.1016/j.jet.2010.07.008.

Pesendorfer, Martin (2002) "Retail Sales: A Study of Pricing Behavior in Supermarkets," *The Journal of Business*, Vol. 75, No. 1, pp. 33–66.

Piccione, Michele and Ran Spiegler (2012) "Price Competition under Limited Comparability," *The Quarterly Journal of Economics*, Vol. 127, No. 1, pp. 97–135.

Ronnen, Uri (1991) "Minimum Quality Standards, Fixed Costs, and Competition," *The RAND Journal of economics*, pp. 490–504.

Rosenthal, Robert W (1980) "A Model in which an Increase in the Number of Sellers Leads to a Higher Price," *Econometrica: Journal of the Econometric Society*, pp. 1575–1579.

Van Zandt, Timothy (2004) "Information Overload in a Network of Targeted Communication," *RAND Journal of Economics*, pp. 542–560.

Varian, Hal R (1980) "A Model of Sales," *The American economic review*, Vol. 70, No. 4, pp. 651–659.

Veall, Michael R (1985) "On Product Standardization as Competition Policy," *Canadian Journal of Economics*, pp. 416–425.

Wolinsky, Asher (1986) "True Monopolistic Competition as a Result of Imperfect Information," *The Quarterly Journal of Economics*, Vol. 101, No. 3, pp. 493–511.

Woodward, Susan E and Robert E Hall (2012) "Diagnosing Consumer Confusion and Sub-Optimal Shopping Effort: Theory and Mortgage-Market Evidence," *American Economic Review*, Vol. 102, No. 7, pp. 3249–76.

Zhu, Chen, Rigoberto A Lopez, and Xiaoou Liu (2016) "Information Cost and Consumer Choices of Healthy Foods," *American Journal of Agricultural Economics*, Vol. 98, No. 1, pp. 41–53.

A Extensions

A.1 Full Attention

This section discusses a benchmark where consumers are not restricted by limited attention. More precisely, 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 such that they learn their match values and prices of both products in the market. For simplicity, we restrict firms' product design $s \in [\underline{s}, \overline{s}]$ where $\underline{s} > v$. 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* $\frac{\alpha}{4}(v + \overline{s})$. *Firms choose* $\overline{s}$ *with probability* 1. *Value shoppers buy with probability 1 if their match value with at least one of the firm is* $v + \overline{s}$.

Thus, different from our model, without limited attention of consumers, firms have no incentive to adopt a mass market product design and will always choose maximum dispersion. Intuitively, an increase in $\overline{s}$ increase 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 consumers 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 limited attention and the distraction effect, the increase in price never outweighs the increase in match value benefited from informative advertisement, and consumers are in average better off. Similar conclusion also holds in the case of persuasive advertisement which induces an increase in v.

Corollary A.2. *Firms' profit and average consumers' surplus increases in v, 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 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 which distinguishes our result and mechanism from classical models with horizontal differentiation.

To see this, consider a setting where 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 4.

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 $\overline{s}_A < \frac{4-3\alpha}{\alpha}v$ 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, in the $\lambda > \frac{1}{2}$- or $\frac{1}{2}$-study equilibrium, i.e., when $\overline{s} \in [\overline{s}_A, \frac{4-3\alpha}{\alpha}v)$, firms strictly prefer to obfuscate (set $A_k = 0$) when charging $\overline{p}$).*

The proposition shows that when the distraction effect is stronger enough, i.e., α and $\overline{s}$ are sufficiently large, firms benefit from distraction effect in equilibrium, i.e., firms who charge $\overline{p}$ in a $\lambda > \frac{1}{2}$- or $\frac{1}{2}$-study equilibrium, make

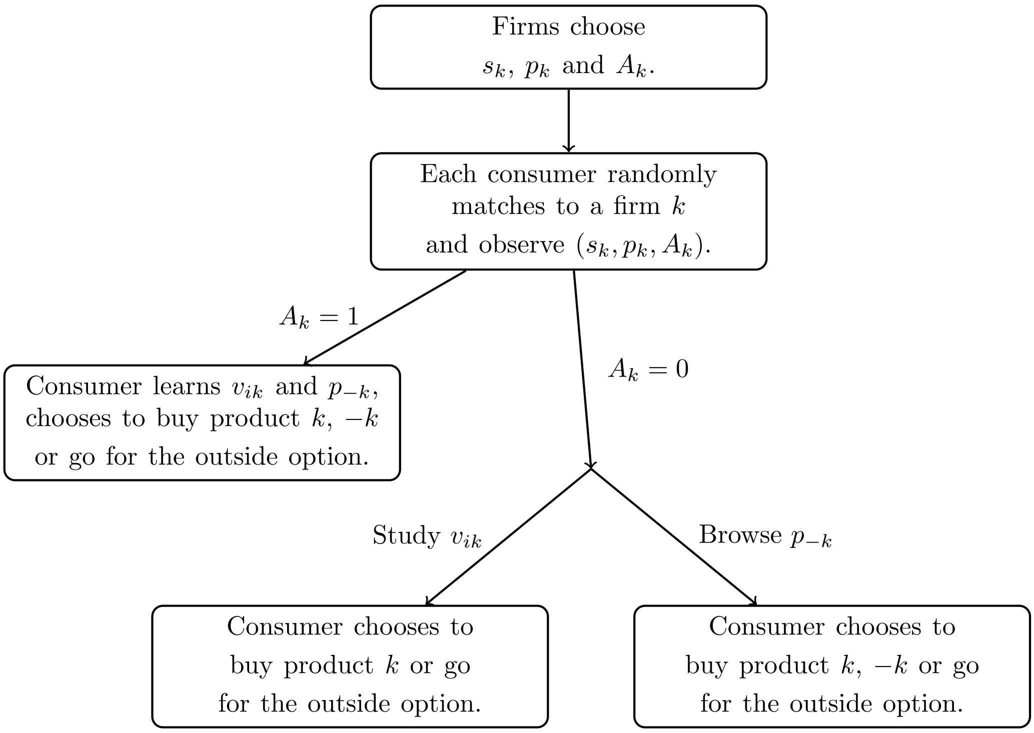

Figure 4: Time-line of the extended game

detailed information available, but prefer to obfuscate this information.[27] The intuition in a $\lambda > \frac{1}{2}$- or $\frac{1}{2}$-study equilibrium, firms earn strictly less than the monopoly profit. 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 Omitted Results and Proofs

B.1 Proof of Lemma 1

Proof. Without loss of generality, we fix $k = 1$. We first consider $s_1 \geq v$, such that $p_1 \geq 0 \geq v - s_1$.

If the value shopper studies match values, she buys if and only if her match value is high. Thus her expected utility of studying equals:

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

On the other hand, if she chooses to browse, she will buy the cheaper product, given that its price is smaller than the expected match value v. Her expected utility of browsing equals:

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

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

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

[27] When α and $\overline{s}$ is large enough, it is not profitable for firms to deviate to higher price 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.

or equivalently

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

in which the inequality is clearly satisfied when $p_1 = v + s_1$ and violated when $p_1 = 0$. Moreover, its first derivative with respect to p_1 equals

$$\frac{\partial\left(U_{\text{study}} - U_{\text{browse}}\right)}{\partial p_1} = \begin{cases} \frac{1}{2} - G_2(p_1) & \text{if } p_1 \leq v; \\ -\frac{1}{2} & \text{if } p_1 > v, \end{cases}$$

which 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 if and only if p_1 is bigger than the threshold.

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

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

which is clearly weakly bigger than $U_{\text{study}} = v - p_1$. On the other hand, when $p_1 \geq v - s_1$, a similar analysis than in the case $s_1 \geq v$ 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 $p_1 = v - s_1$, depending on G_2 and s_1, either the value shopper browses for all p_1, for example when $s_1 = 0$; or she browses if and only if $p_1 < \tilde{p}'$ or $p_1 > \tilde{p}$, for example when $G_2(p) = 0$ for all $p \leq v - s_1$.

The second part of the lemma is simply implied by

$$\frac{\partial\left(U_{\text{study}} - U_{\text{browse}}\right)}{\partial s_1} = \frac{1}{2} > 0 \text{ for all } G_2,\ s_1 \text{ and } p_1 \geq v - s_1.$$

□

B.2 Proof of Proposition 1

Proof. We prove a more general statement than Proposition 1. In particular, we will fully characterize the equilibrium with one proposition and three lemmas without restricting attention to $\overline{s} > v$, and $\overline{s} \in (v(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right], v\frac{(4-3\alpha)}{\alpha})$. The results encompass Proposition 1 and 2, and Proposition E.1 in the Web Appendix as special cases.

Proposition B.1. *In any symmetric equilibrium satisfying the equilibrium-selection assumption, value shoppers study match value if and only if the price is higher than some threshold. The support of prices and the threshold characterizing the value shoppers' search decisions belongs to one of the three cases:*

1. *$\frac{1}{2}$-study equilibrium: Half of the value shoppers study match value while bargain shoppers browse prices with probability 1. Firms either mix between prices with no gaps and mass points in $[\underline{p}, \overline{p}]$ where $\overline{p} \leq v$, or in $[\underline{p}, v] \cup \{\overline{p}\}$ with no mass points and gaps in $[\underline{p}, v]$ and a mass point of probability less than a half at $\overline{p} > v$. Value shoppers study match value for prices higher than the median $\hat{p}$ and browse otherwise.*

2. *$\lambda > \frac{1}{2}$-study equilibrium: $\lambda > \frac{1}{2}$ of the value shoppers study match value while bargain shoppers browse prices with probability 1. Firms mix price in $[\underline{p}, v] \cup \{\overline{p}\}$ with no mass points and gaps in $[\underline{p}, v]$ and a mass point of probability λ at $\overline{p} \in (v, v + \overline{s})$. Value shoppers study match value for price $\overline{p}$ and browse for prices in $[\underline{p}, v]$.*

3. *All-study equilibrium: All value shoppers study match value while bargain shoppers are indifferent between browsing and studying. Firms set price $v + \overline{s}$ with probability 1.*

In all three cases, firms choose $\overline{s}$ at $\overline{p}$. Denote s_p as the design such that value shoppers are indifferent between studying and browsing. In equilibrium, for prices where value shoppers study, firms choose $s \in [s_p, \overline{s}]$; for prices where value shoppers browse, firms choose $s \in [0, s_p)$.

Proof. We divide the proof into multiple statements. Denote G as the equilibrium cumulative price distribution, and $\overline{p}$ and $\underline{p}$ as the supremum and infimum of the price distribution G.

1. Value shoppers study match value with positive probability. Suppose not, then all consumers must browse prices in equilibrium. The two firms are effectively perfect substitute, and engage in Bertrand competition. Firms then make 0 profit. But a firm can secure strictly positive profit by charging an arbitrarily low but strictly positive price ϵ and choosing maximum dispersion $\overline{s}$. Suppose firm 1 charges $p_1 = \epsilon$ and chooses $s_1 = \overline{s}$. By Lemma 1, for small enough ϵ, value shoppers matched with firm 1 study match values for any G. And those value shoppers buy from firm 1 if they find that their match value equals $v+\overline{s}$. Thus firm 1 can secure profit $\frac{\alpha}{4}\epsilon > 0$. This also implies the following statement.

2. Both firms make strictly positive profit. Firms must put no probability mass on $p > v + \overline{s}$.

3. 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 1, the statement is directly implied by the fact that U_{browse} does not depend on s_2.

4. If G put strictly positive mass on prices $p \in (v, v + \epsilon)$ for some $\epsilon > 0$, we must have a mass point at $\overline{p}$ and no mass in $(v, \overline{p})$. First note that firms earn positive profit for $p \in (v, v + \overline{s}]$ if and only if value shoppers study at p. The demand from studying value shoppers are constant at $\frac{1}{2}$ for all prices strictly above v, and browsing consumers do not buy. Thus, there must be no mass in $(v, \overline{p})$ but a mass point at $\overline{p}$ if G put strictly positive mass on prices $p \in (v, v + \epsilon)$ for some $\epsilon > 0$.

Point 4 implies that in equilibrium we either have prices only in $[\overline{p}, v]$, in $[\underline{p}, v] \cup \{\overline{p}\}$, or in $\{\overline{p}\}$.

5. When G puts probability 1 at $\overline{p} > v$, $\overline{p} = v + \overline{s}$. Value shoppers study and bargain shoppers are indifferent between studying and browsing. When firms put probability 1 at $\overline{p} \in (v, v+\overline{s}]$, $U_{\text{study}} > U_{\text{browse}} = 0$ and thus value shoppers strictly prefer to study. On the other hand, bargain shoppers will not buy. Firms thus earn profit $\frac{\alpha}{4}p$ for all $p < v + s$. To maximize profit, firms must choose $\overline{s}$ and $\overline{p} = v + \overline{s}$ in equilibrium.

6. When G puts a mass point of probability $\lambda < 1$ at $\overline{p} > v$, G must put no mass points nor gaps in $[\underline{p}, v]$. When $\lambda \geq \frac{1}{2}$, value shoppers study at $\overline{p}$ and browse for prices in $[\underline{p}, v]$; when $\lambda < \frac{1}{2}$, value shoppers study for prices bigger than the median $\hat{p} \in [\underline{p}, v]$ and browse otherwise. Bargain shoppers browse prices with probability 1. Firms choose $\overline{s}$ at $\overline{p}$. First suppose there is a mass point at $p \in [\underline{p}, v]$. In the case where value shoppers are not indifferent between studying and browsing at p, deviating to $p - \epsilon$ for small ϵ while keeping $s(p)$ fixed would deliver a jump in demand from browsing bargain shoppers (which have positive mass) and browsing value shoppers. On the other hand, demand from studying value shoppers are kept constant and the decrease in profit margin is marginal which means the deviation is profitable. Now consider the case where value shoppers are indifferent between studying and browsing at p. Denote the mass at p as β and the probability that value shoppers study at p as γ. Deviating to $p - \epsilon$ and $s = 0$ induces browsing and gives the following demand change:

$$(1-\alpha)\frac{\beta}{2} + \frac{\alpha}{2}(1-\gamma)\frac{\beta}{2} + \frac{\alpha}{2}\gamma\left[\beta + (1 - \lim_{p' \to p^-} G(p')) - \frac{1}{2}\right] + \frac{\alpha}{2}(1-\gamma)\frac{\beta}{2}.$$

where the first term is the increase in sales from bargain shoppers, the second term is the increase in sales from browsing value shoppers initially assigned to rival, the third term is the increase in sales from studying value shoppers who start browsing, where $\beta + (1 - \lim_{p' \to p^-} G(p'))$ is the probability to sell to initially-assigned value shoppers who browse, and the forth term is the increase in sales from firm's own browsing value shoppers.

It is strictly positive and the deviation is profitable unless $\beta + (1 -$

$\lim_{p'\to p^-} G(p')) - \frac{1}{2} < 0$. Now consider a deviation to $p - \epsilon$ and $s = \overline{s}$, by Lemma 1, value shoppers study which induce the following demand change:

$$(1-\alpha)\frac{\beta}{2} + \frac{\alpha}{2}(1-\gamma)\left[\frac{1}{2} - \frac{\beta}{2} - (1 - \lim_{p'\to p^-} G(p'))\right] + \frac{\alpha}{2}(1-\gamma)\frac{\beta}{2},$$

where the first term is the increase in sales from bargain shoppers, the second term is the increase in sales from browsing value shoppers who start studying, and the third term is the increase in sales from browsing value shoppers initially assigned to rival. Note that the demand change is strictly positive if $\beta + (1 - \lim_{p'\to p^-} G(p')) - \frac{1}{2} < 0$. In this case, undercutting and choosing $s = \overline{s}$ is profitable. Therefore, as there is profitable deviation, i.e., undercutting and choosing $s = 0$ or $\overline{s}$, there is no mass point in $[\underline{p}, v]$.

We show next, by contradiction, that there is no gap in the support of the equilibrium price distribution in $[\underline{p}, v]$. Now suppose there is a gap in $(p, p') \in [\underline{p}, v]$. And consider a deviation to price $p' - \epsilon$ with probability 1 and dispersion $s = 0$ or $s = \overline{s}$ such that value shopper chooses the same search decision pre-deviation at price p. Relative to the prices charged before the deviation in some interval $(p - \epsilon, p)$ for sufficiently small $\epsilon > 0$, this deviation keeps constant the demand but yields a higher profit margin. Since before the deviation firms must have been indifferent between all candidate equilibrium prices, this deviation strictly increases profits. Thus, there is no gap in the support of the equilibrium price distribution in $[\underline{p}, v]$.

Now we characterize value shoppers' search decision. Note that the demand from studying value shoppers are constant at $\frac{1}{2}$. Thus, for $p \leq v$ and $1 - G(p) > \frac{1}{2}$, it is strictly more profitable for firms to induce browsing, e.g., by choosing $s = 0$. Thus, when $\lambda \geq \frac{1}{2}$, $1 - G(p) > \frac{1}{2}$ for all $p \leq v$ and value shoppers browse for prices in $[\underline{p}, v]$. Otherwise, they browse for prices smaller than the median.

To see that bargain shoppers browse with probability 1 in equilibrium, note that there is no mass point at $\underline{p}$, so bargain shoppers must browse prices with probability 1. Finally, we show that firms choose $\overline{s}$ at $\overline{p}$ in equilibrium. Lemma 1 implies that choosing a higher s allows firms to set a higher price and still be able to incentivize studying. Thus, they must choose $\overline{s}$ at $\overline{p}$.

7. When G does not put any mass on intervals $(v, v+\epsilon)$ for any $\epsilon > 0$, firms mix price in $[\underline{p}, \overline{p}]$ without mass points nor gaps. Value shoppers study for prices bigger than the median and browse otherwise. Bargain shoppers browse prices with probability 1. Firms choose $\overline{s}$ at $\overline{p}$. To prove the statement, we first prove that value shoppers who see a price close to $\overline{p}$ at their initially-assigned firm must study match value. Then using the same arguments in point 6, we prove that there is no mass points nor gaps in $[\underline{p}, \overline{p}]$.

First note that there cannot be a mass point at $\overline{p}$. Suppose towards a contradiction that there is a mass point at $\overline{p}$. First, if value shoppers are not indifferent between studying and browsing at $\overline{p}$, undercutting would not change their behavior. Undercutting is profitable as it induces a jump in demand from both bargain shoppers and browsing value shoppers and keep fixed the demand from studying value shoppers. Second, suppose value shoppers are indifferent between studying and browsing at $\overline{p}$ but strictly prefer to study at $\overline{p} - \epsilon$ for small ϵ, given fixed s. Denote β as the mass of G on $\overline{p}$ and γ the fraction of value shoppers who choose to study at $\overline{p}$. At $\overline{p}$, firms' profit equals:

$$\left[(1-\alpha)\frac{\beta}{2} + \frac{\alpha}{2}(\frac{\gamma}{2} + \frac{\beta(1-\gamma)}{2}) + \frac{\alpha}{2}\frac{\beta(1-\gamma)}{2}\right]\overline{p}. \tag{B.1}$$

The first term captures demand from bargain shoppers who buy if the rival charges $\overline{p}$ as well. The second term the demand from initially assigned value shoppers who buy with probability $\frac{1}{2}$ if they study and buy with probability $\frac{1}{2}$ if they browse and see the rival also charges $\overline{p}$. Third, demand from browsing value shoppers initially assigned to the rival. Undercutting at $\overline{p} - \epsilon$ for $\epsilon \to 0$ and fixing s gives profit:

$$\left[(1-\alpha)\beta + \frac{\alpha}{4} + \frac{\alpha}{2}\beta(1-\gamma)\right]\overline{p}, \tag{B.2}$$

where the first term captures that the firm attracts all bargain shoppers who see larger price at the rival, the second term captures that value shoppers initially assigned to the firm start to study, and the third term the demand from browsing value shoppers initially assigned to the rival. The profits after the deviation are higher. Now suppose value shoppers are indifferent between studying and browsing at $\overline{p}$ but strictly prefer to browse at $\overline{p}-\epsilon$ for small ϵ, given fixed s. At $\overline{p}$, firms' profit is given by (B.1). By Lemma 1, firms must have chosen $s<v$ at $\overline{p}$. Consider a deviation to $\overline{s}$ and undercut at $\overline{p}-\epsilon$. By Lemma 1, such a deviation induces value shoppers to study and thus the profit is again given by (B.2) and is profitable. Thus, there is no mass point at $\overline{p}$.

Now as there is no mass point at $\overline{p}$, for prices close to $\overline{p}$, if value shoppers browse price, the demand firms get vanishes when p goes to $\overline{p}$ and it contradicts point 2. We conclude that value shoppers study with probability one as prices approach $\overline{p}$.

Next, using similar arguments in point 6, we can prove that there is no mass points nor gaps in $[\underline{p},\overline{p}]$. As a result, bargain shoppers browse prices with probability 1. Moreover, as firms are better off inducing value shoppers to study for prices bigger than the median, firms will choose s big enough such that value shoppers study for prices bigger than the median. Last, at $\overline{p}$, firms must choose $\overline{s}$ as otherwise they could deviate to higher price than $\overline{p}$, choose $\overline{s}$, and induce value shoppers to study.

8. In equilibrium, at price p where value shoppers study, firms choose $s\geq s_p$, while at price p where value shoppers browse, firms choose $s<s_p$, where s_p is the threshold where value shoppers are indifferent between studying and browsing. The statement is implied by Lemma 1 and the fact that firms' profit is not affected by s given consumers' search decision. □

The following three lemmas present the condition of existence of the three types of equilibrium as described in Proposition B.1, and in particular show that only the $\lambda>\frac{1}{2}$-study equilibrium exists when $\overline{s}\in(v(2-\alpha)\left[\frac{1}{\alpha}-\frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right], v\frac{(4-3\alpha)}{\alpha})$,

Lemma B.1. *There exists a $\frac{1}{2}$-study equilibrium if and only if $\bar{s}\leq\overline{s}_{\frac{1}{2}}$ where*

$\overline{s}_{\frac{1}{2}}$ *is given by the following equation:*

$$\overline{s}_{\frac{1}{2}} = v(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right].$$

Moreover, the equilibrium pricing strategy and the equilibrium industry profit are uniquely pinned down by $v, \overline{s}, \alpha$ *in the* $\frac{1}{2}$*-study equilibrium.* $\overline{p}$ *increases in* $\overline{s}$*.*

Proof. In the following, we first assume that a $\frac{1}{2}$-study equilibrium exists such that the median price is smaller than $\hat{p}$, and compute the equilibrium supremum price $\overline{p}$ and median price $\hat{p}$, and then show that when, and only when, $\overline{s}$ is small enough, $\hat{p} \leq v$ and therefore a $\frac{1}{2}$-study equilibrium exists.

In the $\frac{1}{2}$-study equilibrium, by Proposition B.1, value shoppers study if they see a price bigger than the median, and browse otherwise. Denote the median as $\hat{p}$, the equal-profit condition in the mixed price strategy equilibrium implies for $p \geq \hat{p}$ and $p \neq \overline{p}$:

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

in which $\frac{\alpha}{4}$ is the demand from studying value shoppers and $(1-\alpha)(1-G(p))$ is the demand from browsing bargain shoppers. For $p < \hat{p}$:

$$\left[\frac{\alpha}{2}(1-G(p)+G(\hat{p})-G(p)) + (1-\alpha)(1-G(p))\right]p = \frac{\alpha}{4}\overline{p} = \frac{4-\alpha}{4}\underline{p}$$

in which $\dfrac{\alpha}{2}(1-G(p))$ is the demand from browsing value shoppers matched with the firm and $\dfrac{\alpha}{2}(G(\hat{p})-G(p))$ is the demand from browsing value shoppers matched with the rival of the firm.

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

$$1-G(p) = \begin{cases} \dfrac{\alpha}{4(1-\alpha)}\dfrac{\overline{p}-p}{p} & \text{for } p \geq \hat{p} \text{ and } p \neq \overline{p}; \\ \dfrac{\alpha}{4}\dfrac{\overline{p}+p}{p} & \text{for } p < \hat{p}; \end{cases} \tag{B.3}$$

$$g(p) = \begin{cases} \dfrac{\alpha}{4(1-\alpha)} \dfrac{\overline{p}}{p^2} & \text{for } p > \hat{p} \text{ and } p \neq \overline{p}; \\ \dfrac{\alpha}{4} \dfrac{\overline{p}}{p^2} & \text{for } p < \hat{p}; \end{cases} \tag{B.4}$$

The median price is given by $G(\hat{p}) = \frac{1}{2}$, i.e., $\hat{p} = \dfrac{\alpha}{2-\alpha}\overline{p}$. We now characterize the supremum price. Denote the $\mathscr{G}(\overline{p}) = U_{\text{study}} - U_{\text{browse}}$. At $\overline{p}$, value shoppers should be indifferent to study or browse, i.e., $\mathscr{G}(\overline{p}) = 0$. The equilibrium supremum price is given by the solution of

$$\begin{gathered} \frac{1}{2}(\overline{p} + \overline{s} - v) - [\overline{p} - E_G(p)] = 0 \text{ if } \overline{p} \leq v; \\ \text{or} \\ \frac{1}{2}(v + \overline{s} - \overline{p}) - G(v)\,(v - E_G(p \mid p < v)) = 0 \text{ if } \overline{p} > v, \end{gathered} \tag{B.5}$$

Using the c.d.f. and p.d.f. in equation (B.3) and (B.4), we obtain the expected price and the truncated expected price as a function of $\overline{p}$: When $\overline{p} \leq v$:

$$E_G(p) = \frac{\alpha \overline{p}}{4} \left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha} \log(\frac{2-\alpha}{\alpha}) \right),$$

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

$$G(v) E_G(p \mid p < v) = \int_{\underline{p}}^{v} p g(p)\, dp = \frac{\alpha \overline{p}}{4} \left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha} \log(\frac{(2-\alpha)v}{\alpha \overline{p}}) \right).$$

Substituting the two equations into equation (B.5) gives us the following system of equations

$$\begin{gathered} \frac{1}{2}(\overline{p} + \overline{s} - v) - \left[\overline{p} - \frac{\alpha \overline{p}}{4} \left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha} \log(\frac{2-\alpha}{\alpha}) \right) \right] = 0 \text{ if } \overline{p} \leq v; \\ \text{or} \\ \frac{1}{2}(v + \overline{s} - \overline{p}) - G(v) v + \frac{\alpha \overline{p}}{4} \left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha} \log(\frac{(2-\alpha)v}{\alpha \overline{p}}) \right) = 0 \text{ if } \overline{p} > v. \end{gathered}$$

which is then rewritten as:

$$\overline{p} = \frac{\overline{s} - v}{1 - \frac{\alpha}{2}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{2-\alpha}{\alpha})\right)} \leq v, \text{ or}$$
$$\frac{\overline{p}}{v}\left[\frac{3\alpha - 2}{4(1-\alpha)} - \frac{\alpha}{4}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{(2-\alpha)v}{\alpha\overline{p}})\right)\right] = \frac{2-\alpha}{4(1-\alpha)} + \frac{1}{2}\frac{\overline{s}}{v} \text{ if } \overline{p} > v. \tag{B.6}$$

We now prove that $\overline{p}$ is strictly increasing in $\overline{s}$ and pin down the threshold $\overline{s}_{\frac{1}{2}}$ such that $\hat{p} = v$. Both combined implies that the $\frac{1}{2}$-study equilibrium exists if and only if $\overline{s} \leq \overline{s}_{\frac{1}{2}}$. The strict monotonically also implies that $\overline{p}$, and thus equilibrium pricing strategy and the industry profit, are uniquely pinned down. We will divide the proof into two cases which correspond to the sign of $1 - \frac{\alpha}{2}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{2-\alpha}{\alpha})\right)$.

1. $1 - \frac{\alpha}{2}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{2-\alpha}{\alpha})\right) > 0$**.** We will prove that $\mathscr{G}(\overline{p})$ is continuous at $\overline{p} = v$ and that $\mathscr{G}(\overline{p})$ is strictly monotonic in $\overline{p}$. Both combined implies that there exists a unique solution of $\mathscr{G}(\overline{p}) = 0$. First we have:

$$\mathscr{G}(\overline{p}) = \begin{cases} \frac{1}{2}(\overline{p} + \overline{s} - v) - [\overline{p} - E_G(p)] & \text{for } \overline{p} \leq v; \\ \frac{1}{2}(v + \overline{s} - \overline{p}) - G(v)\,(v - E_G(p \mid p < v)) & \text{for } \overline{p} > v, \end{cases}$$

At $\overline{p} = v$, $G(v) = 1$ and $E_G(p \mid p < v) = E_G(p)$. Therefore $\mathscr{G}(\overline{p})$ is continuous at $\overline{p} = v$. For $\overline{p} \leq v$, we have

$$\frac{\partial \mathscr{G}(\overline{p})}{\partial \overline{p}} = -\frac{1}{2} + \frac{\alpha}{4}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{2-\alpha}{\alpha})\right) < 0$$

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

$$\frac{\partial \mathscr{G}(\overline{p})}{\partial \overline{p}} = -\frac{1}{2} + \frac{\alpha}{4}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log\frac{(2-\alpha)v}{\alpha\overline{p}}\right) < 0$$

Thus, if a $\frac{1}{2}$-study equilibrium exists, the equilibrium pricing strategy has to be unique. Moreover,

$$\frac{\partial \overline{p}}{\partial \overline{s}} = -\frac{\partial \mathscr{G}}{\partial \overline{p}} / \frac{\partial \mathscr{G}}{\partial \overline{s}} = -2\frac{\partial \mathscr{G}}{\partial \overline{p}} > 0$$

We now argue that $\hat{p} < v$ when $\overline{s}$ is sufficiently small and $\hat{p} > v$ when $\overline{s}$ is sufficiently large, which combined with $\frac{\partial \overline{p}}{\partial \overline{s}} > 0$, implies that $\hat{p} \leq v$ if and only if $\overline{s}$ is small enough. To see this, note that (B.6) implies that for $\overline{s} \to v$, $\overline{p} \to 0$ and therefore $\hat{p} \leq \overline{p}$ as well. Note also that for $\overline{s} \to \infty$, $\overline{p}$ goes to infinity as well because the left-hand-side in the second line of (B.6) increases in $\overline{p}$. Because $\hat{p} = \dfrac{\alpha}{2-\alpha}\overline{p}$, it follows that $\hat{p} > v$. Because $\dfrac{\partial \overline{p}}{\partial \overline{s}} > 0$, there exists a unique $\overline{s}_{\frac{1}{2}}$ threshold for $\overline{s}$ such that $\hat{p} > v$ if $\overline{s} > \overline{s}_{\frac{1}{2}}$ and $\hat{p} < v$ if $\overline{s} < \overline{s}_{\frac{1}{2}}$.

Thus, a $\frac{1}{2}$-study equilibrium exists if and only if $\overline{s} \leq \overline{s}_{\frac{1}{2}}$. The value of $\overline{s}_{\frac{1}{2}}$ will be computed in the proof of Lemma B.2.

2. $1 - \frac{\alpha}{2}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{2-\alpha}{\alpha})\right) \leq 0$**.** In this case, it is obvious from equation (B.6) that there does not exists a $\frac{1}{2}$-study equilibrium where $\overline{p} \leq v$ and thus we look at the case where $\overline{p} > v$. We first prove if there exists a $\frac{1}{2}$-study equilibrium, it has to be unique. From previous computation, we have

$$\frac{\partial \mathscr{G}(\overline{p})}{\partial \overline{p}} = -\frac{1}{2} + \frac{\alpha}{4}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{(2-\alpha)v}{\alpha \overline{p}})\right)$$

which is monotonically decreasing in $\overline{p}$. It implies that $\mathscr{G}(\overline{p})$ is single peaked: It either is always decreasing in $\overline{p}$, or it is increasing in $\overline{p}$ at $\overline{p} = v$ and decreasing in $\overline{p}$ if and only if $\overline{p}$ is big enough. Uniqueness of solution of $\mathscr{G}(\overline{p}) = 0$ is obviously guaranteed in the former case. In the latter case, first note that $\mathscr{G}(\overline{p}) > 0$ at $\overline{p} = v$, i.e., we have:

$$\mathscr{G}(v) = \frac{1}{2}(\overline{s}) - v + \frac{\alpha v}{4}\left(\log(\frac{4-\alpha}{2-\alpha}) + \frac{1}{1-\alpha}\log(\frac{(2-\alpha)}{\alpha})\right) > 0.$$

Note that because $G(p)$ first increases for prices above v and then strictly decreases, there exists a unique $p' > v$ such that $G(p') = G(v) > 0$. Thus, for prices $p \in (v, p')$, $G(p) > 0$, and because $G(\overline{p}) = 0$, we must have $\overline{p} > p'$. Lastly, as $G(\cdot)$ is strictly decreasing for prices above p', $\overline{p}$ is unique.

Moreover, as $\overline{p} > p'$, we have

$$\frac{\partial \mathscr{G}(\overline{p})}{\partial \overline{p}} < 0,$$

which implies

$$\frac{\partial \overline{p}}{\partial \overline{s}} > 0.$$

Therefore, there exists a unique $\overline{s}_{\frac{1}{2}}$ threshold for $\overline{s}$ such that $\hat{p} > v$ if $\overline{s} > \overline{s}_{\frac{1}{2}}$ and $\hat{p} < v$ if $\overline{s} < \overline{s}_{\frac{1}{2}}$. A $\frac{1}{2}$-study equilibrium exists if and only if $\overline{s} \leq \overline{s}_{\frac{1}{2}}$. The value of $\overline{s}_{\frac{1}{2}}$ will be computed in the proof of Lemma B.2.

We conclude that $\overline{p}$ is unique in the $\frac{1}{2}$-study equilibrium. Because equilibrium profits and prices are pinned down by $\overline{p}$, it follows that also equilibrium prices and profits are unique in a $\frac{1}{2}$-study equilibrium. This concludes the proof. □

Lemma B.2. *There exists a $\lambda > \frac{1}{2}$-study equilibrium if and only if $\bar{s} \in (\underline{s}_\lambda, \overline{s}_\lambda)$ where $\underline{s}_\lambda = \overline{s}_{\frac{1}{2}}$ and $\overline{s}_\lambda = v\left[\frac{4-3\alpha}{\alpha}\right]$. The equilibrium pricing strategy and industry profit are uniquely pinned down by $v, \overline{s}, \alpha$ in the $\lambda > \frac{1}{2}$-study equilibrium. Moreover, $\lambda = 1 - G(v)$ is increasing in $\overline{s}$ from $\frac{1}{2}$ at $\overline{s} = \underline{s}_\lambda$ to 1 at $\overline{s} = \overline{s}_\lambda$.*

Proof. In the $\lambda > \frac{1}{2}$-study equilibrium, value shoppers study if they see price $\overline{p}$, and browse for prices in $[\underline{p}, v]$. The equal-profit condition in equilibrium implies that for $p \leq v$:

$$\left[\frac{\alpha}{2}(1 - G(p) + G(v) - G(p)) + (1-\alpha)(1 - G(p))\right] p = \frac{\alpha}{4}\overline{p} = \frac{4 - 2\alpha(1 - G(v))}{4}\underline{p}$$

where $1 - G(p)$ is the probability of selling to a browsing value or bargain shopper, and $G(v) - G(p)$ 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:

$$1 - G(p) = \frac{\alpha}{4}\frac{\overline{p} + 2(1 - G(v))p}{p} \text{ for } p \leq v; \tag{B.7}$$

$$g(p) = \frac{\alpha}{4}\frac{\overline{p}}{p^2} \text{ for } p \leq v. \tag{B.8}$$

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

$$
\begin{aligned}
1 - G(v) &= \frac{\alpha}{4}\frac{\overline{p} + 2(1 - G(v))v}{v} \\
(1 - G(v))\left(1 - \frac{\alpha}{2}\right) &= \frac{\alpha\overline{p}}{4v} \\
1 - G(v) &= \frac{\alpha}{2(2-\alpha)}\frac{\overline{p}}{v}.
\end{aligned} \tag{B.9}
$$

In the following, we will first assume a $\lambda > \frac{1}{2}$ study equilibrium exists, characterize the equilibrium proportion of studying value shoppers $\lambda = 1 - G(v)$ and then verify the conditions of its existence, i.e., $1 - G(v) \in (\frac{1}{2}, 1)$. In equilibrium, at $\overline{p}$ value shoppers should be indifferent between studying and browsing:

$$
\frac{1}{2}(v + \overline{s} - \overline{p}) - G(v)\left(v - E_G(p \mid p < v)\right) = 0 \tag{B.10}
$$

By equation (B.9),

$$
\overline{p} = \frac{2\lambda v(2-\alpha)}{\alpha} \tag{B.11}
$$

and by equation (B.8), we have

$$
\begin{aligned}
\int_{\underline{p}}^{v} pg(p)\,dp &= \int_{\underline{p}}^{v} \frac{\alpha}{4}\frac{\overline{p}}{p}\,dp \\
&= \frac{\alpha\overline{p}}{4}\log\left(\frac{v}{\underline{p}}\right) \\
&= \frac{\alpha\overline{p}}{4}\left(\log(\frac{v}{\overline{p}}\frac{4 - 2\alpha(1 - G(v))}{\alpha})\right)
\end{aligned} \tag{B.12}
$$

Substituting the equations (B.11) and (B.12) to equation (B.10) gives us:

$$
\frac{1}{2}\left(v + \overline{s} - \frac{2\lambda v(2-\alpha)}{\alpha}\right) - v + \lambda v + \frac{\alpha\overline{p}}{4}\left(\log(\frac{v}{\overline{p}}\frac{4 - 2\alpha(1 - G(v))}{\alpha})\right) = 0
$$

which is simplified to:

$$
\frac{1}{2}\left(\frac{\overline{s}}{v} - 1\right) + \lambda\left[1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{2 - \alpha\lambda}{\lambda(2-\alpha)}\right)\right)\right] = 0 \tag{B.13}
$$

With some abuses of notations, denote $\mathscr{G}(\lambda)$ as follows:

$$\mathscr{G}(\lambda) = \frac{1}{2}\left(\frac{\overline{s}}{v} - 1\right) + \lambda\left[1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{2-\alpha\lambda}{\lambda(2-\alpha)}\right)\right)\right] \tag{B.14}$$

The derivatives of the function $\mathscr{G}$ are:

$$\begin{aligned}
\frac{\partial \mathscr{G}}{\partial \overline{s}} &= \frac{1}{2v} > 0 \\
\frac{\partial \mathscr{G}}{\partial \lambda} &= 1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{2-\alpha\lambda}{\lambda(2-\alpha)}\right)\right) \\
&\quad + \frac{(2-\alpha)\lambda}{2}\left(\frac{\lambda(2-\alpha)}{2-\alpha\lambda}\right)\left(\frac{-\alpha\lambda(2-\alpha)-(2-\alpha)(2-\alpha\lambda)}{(2-\alpha)^2\lambda^2}\right) \\
&= 1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{2-\alpha\lambda}{\lambda(2-\alpha)}\right)\right) - \left(\frac{2-\alpha}{2-\alpha\lambda}\right)
\end{aligned} \tag{B.15}$$

By equation (B.13),

$$1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{2-\alpha\lambda}{\lambda(2-\alpha)}\right)\right) = -\frac{1}{2\lambda}\left(\frac{\overline{s}}{v} - 1\right) < 0$$

Thus, $\frac{\partial \lambda}{\partial \overline{s}} = -\frac{\partial \mathscr{G}}{\partial \overline{s}} / \frac{\partial \mathscr{G}}{\partial \lambda} > 0$. Equation (B.13) implies that when $\overline{s} \to v$, $\lambda \to 0$; when $\overline{s} \to \infty$, $\lambda \to \infty$, therefore there exists two thresholds $\underline{s}_\lambda$ and $\overline{s}_\lambda > \underline{s}_\lambda$, such that $\lambda \in (\frac{1}{2}, 1)$ if and only if $\overline{s} \in (\underline{s}_\lambda, \overline{s}_\lambda)$. Thus a $\lambda > \frac{1}{2}$-study equilibrium exists if and only if $\overline{s} \in (\underline{s}_\lambda, \overline{s}_\lambda)$. Moreover, as $\frac{\partial \lambda}{\partial \overline{s}} > 0$, λ and thus $\overline{p}$ is unique in the $\lambda > \frac{1}{2}$-study equilibrium. Because equilibrium profits and prices are pinned down by $\overline{p}$, it follows that also equilibrium prices and profits are unique in a $\lambda > \frac{1}{2}$-study equilibrium.

Now we pin down the two thresholds $\underline{s}_\lambda$ and $\overline{s}_\lambda$. First, we show that $\underline{s}_\lambda = \overline{s}_{\frac{1}{2}}$: We prove in the following that $\mathscr{G}(\lambda = \frac{1}{2}) = 0$ if and only if

$\mathscr{G}(\overline{p} \mid \hat{p} = v) = 0$. From equation (B.5) and using that $\hat{p} = \dfrac{\alpha}{2-\alpha}\overline{p} = v$,

$$\begin{aligned}
\mathscr{G}(\overline{p} \mid \hat{p} = v) &= \frac{1}{2}(v + \overline{s} - \overline{p}) - G(v)\left(v - E_G(p \mid p < v)\right) \\
&= \frac{1}{2}(v + \overline{s} - \frac{2-\alpha}{\alpha}v) - \frac{v}{2} + \frac{2-\alpha}{4}v\left(\log(\frac{4-\alpha}{2-\alpha})\right) \\
&= \frac{\overline{s}}{2} + v\left[-\frac{2-\alpha}{2\alpha} + \frac{2-\alpha}{4}\left(\log(\frac{4-\alpha}{2-\alpha})\right)\right]
\end{aligned}$$

On the other hand, by equation (B.13),

$$\begin{aligned}
\mathscr{G}(\lambda = \frac{1}{2}) &= \frac{1}{2}\left(\frac{\overline{s}}{v} - 1\right) + \frac{1}{2}\left[1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right)\right] \\
&= \frac{\overline{s}}{2v} + \left[-\frac{2-\alpha}{2\alpha} + \frac{2-\alpha}{4}\left(\log(\frac{4-\alpha}{2-\alpha})\right)\right] \\
&= v\mathscr{G}(\overline{p} \mid \hat{p} = v)
\end{aligned}$$

Thus, $\overline{s}_{\frac{1}{2}} = \underline{s}_\lambda$ and is given by the following equation:

$$\begin{aligned}
\mathscr{G}(\lambda = \frac{1}{2}) = \frac{1}{2}\left(\frac{\overline{s}_{\frac{1}{2}}}{v} - 1\right) + \frac{1}{2}\left[1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right)\right] = 0 \\
\Leftrightarrow \overline{s}_{\frac{1}{2}} = v(2-\alpha)\left[\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right]
\end{aligned}$$

Similarly, $\overline{s}_\lambda$ is given by the following equation:

$$\begin{aligned}
\mathscr{G}(\lambda = 1) = \frac{1}{2}\left(\frac{\overline{s}_\lambda}{v} - 1\right) + \left[1 - (2-\alpha)\left(\frac{1}{\alpha} - \frac{1}{2}\log\left(\frac{2-\alpha}{2-\alpha}\right)\right)\right] = 0 \\
\Leftrightarrow \frac{\overline{s}_\lambda}{2v} - \frac{1}{2} + 1 - \frac{2-\alpha}{\alpha} = 0 \\
\Leftrightarrow \overline{s}_\lambda = v\left[\frac{2(2-\alpha)}{\alpha} - 1\right] \\
\Leftrightarrow \overline{s}_\lambda = v\left[\frac{4-3\alpha}{\alpha}\right]
\end{aligned}$$

□

Lemma B.3. *Suppose all bargain shoppers browse if they are indifferent.*

There exists an all-study equilibrium where all value shoppers study and $\overline{p} = v + \overline{s}$ if and only if $\overline{s}$ is bigger than some threshold $\underline{s}_1 = v\left[\frac{4-3\alpha}{\alpha}\right] = \overline{s}_\lambda$.

Proof. In the all-study equilibrium, both firms charge $\overline{p} = v + \overline{s}$ and value shoppers have no incentive to browse prices. Suppose all bargain shoppers browse, the all-study equilibrium exists if and only if firms have no incentive to deviate to $p = v$ and $s = 0$, which induces the deviating firm's initially-assigned value-shoppers to browse and buy with probability one from the deviating firm and attracts all bargain shoppers and is the best deviation firms could make. Thus, there exists an all-study equilibrium if and only if:

$$\begin{aligned}\frac{\alpha}{4}(v+\overline{s}) &\geq \left(\frac{\alpha}{2}+(1-\alpha)\right)v\\ v+\overline{s} &\geq \frac{4-2\alpha}{\alpha}v\\ \overline{s} &\geq \frac{4-3\alpha}{\alpha}v\end{aligned}$$

□

□

B.3 Proof of Lemma 2

Proof. We proof this lemma for the λ-study equilibrium, which exists if $\overline{s} \in \left(v(2-\alpha)\left[\frac{1}{\alpha}-\frac{1}{2}\log\left(\frac{4-\alpha}{2-\alpha}\right)\right], \frac{4-3\alpha}{\alpha}v\right)$. First, Equation (3) is shown in the proof of Lemma B.2.

To show the comparative statics of firms' profit and consumers' surplus, we make two observations here. First, from (B.7), when $\overline{p}' \geq \overline{p}$, $G(p \mid \overline{p}')$ first order stochastic dominates $G(p \mid \overline{p})$, and thus equilibrium price increases in the sense of F.O.S.D. in $\overline{p}$. Second, $\lambda = 1 - G(v)$ is the mass point at $\overline{p}$ and therefore also the share of studying value shoppers in equilibrium. From (3), we see that λ is positively correlated with $\overline{p}$ in equilibrium.

Next, using the definition of λ and evaluating the equal-profit condition at $p = v$, we can rewrite the equal-profit condition as

$$\frac{\alpha}{4}\overline{p} = \frac{(2-\alpha)\lambda}{2}v,$$

which implies that equilibrium profit is positively correlated with the equilibrium share of studying consumers. Intuitively, firms profits increase if fewer consumers compare prices.

Consumer surplus, on the other hand, is negatively correlated with λ. To see this, note first that bargain shoppers' ex-ante surplus is given by:

$$\lambda \int_{\underline{p}}^{v} (v-p)g(p)\,dp + \int_{\underline{p}}^{v} \left[\int_{\underline{p}}^{p'} (v-p)g(p)\,dp + (v-p')(1-G(p')) \right] g(p')\,dp'$$

Because at $\overline{p}$ value shoppers are indifferent between studying and browsing, and because they strictly prefer browsing for all other prices, value shoppers' have the same ex-ante surplus as bargain shoppers. As $G(p)$ increases (in the sense of first order stochastic dominance) in $\overline{p}$ which in turn increases in λ, surplus of both types of consumers is negatively correlated with $\overline{p}$ and λ. □

B.4 Proof of Proposition 2

Proof. Lemma B.2 shows the equilibrium share of studying value shoppers is between 1/2 and 1, and is increasing in $\overline{s}$. Moreover, equation (B.14) shows that $\frac{\partial \lambda}{\partial(\overline{s}/v)} = v\frac{\partial \lambda}{\partial \overline{s}} > 0$ which proves the result. □

B.5 Proof of Corollary 1

Proof. Note that firms' profit in equilibrium is equal to $\frac{\alpha}{4}\overline{p}$. By Lemma B.2, $\frac{\partial \overline{p}}{\partial \overline{s}} > 0$ which proves the corollary. □

B.6 Proof of Corollary 2

Proof. We first analyze the effect of increasing $\overline{s}$ on consumer surplus. Note that by Lemma B.2, $\frac{\partial \lambda}{\partial \overline{s}} \geq 0$. As Lemma 2 shows that consumers' surplus decreases in λ this proves the result. □

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 exists 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 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 $\frac{\alpha}{4}(v + \overline{s})$ by charging $v + \overline{s}$ and as they sell to no consumers if $\overline{p} > v + \overline{s}$, $\overline{p} = v + \overline{s}$. 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 firm 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 $p' < v$, 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 $p > v$. Thus there are two possible candidates of equilibrium price distribution, where the first corresponds to a distribution with no gaps and support $[\underline{p}, v + \overline{s}]$ where $\underline{p} > v$, and the second corresponds to a distribution with one gap and support $[\underline{p}, v] \cup [\tilde{p}, v + \overline{s}]$ for some $\tilde{p} > v$. Next, when the support of the equilibrium price is $[\underline{p}, v + \overline{s}]$ where $\underline{p} > v$, we have

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

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

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

for some $1-G(v)<1$. 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 exists an equilibrium where $s<\overline{s}$. Note that for all $p\neq \underline{p},\tilde{p}$ and $p<v+\overline{s}$, 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 $\underline{s}>v$, 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. □

B.8 Proof of Corollary A.1

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

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

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

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

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

Total surplus in this case is equal to:

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

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

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

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

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

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

B.9 Proof of Corollary A.2

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

Now, we consider the case where $\frac{\overline{s}}{v} < \frac{4-3\alpha}{\alpha}$. As shown in the proof of

Corollary A.1, total surplus is equal to

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

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

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

and obviously increases in v. $\square$

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, 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 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 bigger than $\overline{p}$. First note that it obviously hold when $\overline{s} \geq \frac{4-3\alpha}{\alpha}v$ as $\overline{p} = \underline{p} = v + \overline{s}$. For $\overline{s} < \frac{4-3\alpha}{\alpha}v$, it is sufficient to prove that first, $v + \overline{s} - \overline{p} \leq v - \underline{p}$ 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 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 $v + \overline{s} - \overline{p} \leq v - \underline{p}$ is true for big enough $\overline{s}$ and α. First note that for $\overline{s} \to \frac{4-3\alpha}{\alpha}v$, $\overline{p} \to v + \overline{s}$ and $\underline{p} \to v$ 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 $\overline{s} < \frac{4-3\alpha}{\alpha}v$. For big enough $\overline{s}$ such that the equilibrium is a $\lambda > \frac{1}{2}$-study equilibrium. Recalling that $\underline{p} = \frac{\alpha}{4-2\alpha(1-G(v))}\overline{p}$ and $(1 - G(v)) = \frac{\alpha}{2(2-\alpha)}\frac{\overline{p}}{v}$, we have

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

Evaluated at $\alpha = 1$, $\overline{s} = \frac{4-3\alpha}{\alpha}v = v$ and $\lambda = 1$, we have $\overline{p} = 2v$ 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 $\frac{4-3\alpha}{\alpha}v$, we have $v + \overline{s} - \overline{p} < v - \underline{p}$. 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 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 $\frac{4-3\alpha}{\alpha}v$, $\overline{p}$ converges to $v + s$ so that $\overline{p} - \overline{s} > 0$ and therefore $p - \overline{s} > \underline{p}$, its derivative with respect to p shares the same sign as

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

As we look at the case where s is big enough such that the equilibrium is a $\lambda > \frac{1}{2}$-study equilibrium, it could be rewritten as

$$\begin{aligned}
&1 - G(p - \overline{s}) - g(p - \overline{s})(p - \overline{s}) - \overline{s}g(p - \overline{s}) \\
=&\frac{\alpha}{4}\frac{\overline{p}}{p - \overline{s}} + \frac{\alpha}{4}2(1 - G(v)) - \frac{\alpha}{4}\frac{\overline{p}}{p - \overline{s}} - \overline{s}\frac{\alpha}{4}\frac{\overline{p}}{(p - \overline{s})^2} \\
=&\frac{\alpha}{4}\left[2(1 - G(v)) - \frac{\overline{p}\overline{s}}{(p - \overline{s})^2}\right]
\end{aligned} \tag{B.16}$$

Equation (B.16) is negative for all $p \geq \overline{p}$ if it is negative at $p = v + \overline{s}$. Using this and $(1 - G(v)) = \frac{\alpha}{2(2-\alpha)}\frac{\overline{p}}{v}$, 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 $\overline{s} = \frac{4-3\alpha}{\alpha} v$, the sufficient condition becomes

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

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 $\frac{4-3\alpha}{\alpha} v$, 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 $\frac{4-3\alpha}{\alpha} v$, firm k does not want to deviate to prices weakly above $\overline{p}$ and $A_k = 1$. This concludes the proof. $\square$