

# Browsing versus Studying: A Pro-Market Case for Regulation\*

Paul Heidhues

Düsseldorf Institute for Competition Economics

Johannes Johnen

Université catholique de Louvain and CORE

Botond Kőszegi

Central European University

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## Abstract

We identify a novel competition-policy-based argument for regulating the secondary features of complex or complexly-priced products when consumers have limited attention and therefore face a tradeoff between superficially understanding more products (browsing) and fully understanding fewer products (studying). Interventions limiting ex-post consumer harm through safety regulations, a strict liability regime, an unfair contract terms principle, or other methods free consumers from worrying about the regulated features, enabling them to do more browsing and thereby enhancing competition. We show that for a pro-competitive effect to obtain, the regulation must apply to the secondary features, and not to the total price or value of the product, and it might have to be broad in scope. Furthermore, the benefits of regulating some markets may manifest themselves in other markets. As an auxiliary positive prediction, we establish that because low-value consumers are often more likely to study than high-value consumers, the average price consumers pay can be increasing in the share of low-value consumers. This prediction helps explain why a number of essential products are more expensive in lower-income neighborhoods.

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# 1 Introduction

In this paper, we identify a novel and powerful competition-policy-based argument for regulating the secondary features of complex or complexly-priced products when consumers have limited attention. Consumers shopping for complex products must decide how much attention to devote to each offer. A mobile-phone buyer, for instance, may spend a little bit of effort to find out an offer’s basic features (e.g., the monthly fee and amount of included data), or more effort to also understand the contract’s precise conditions, additional fees, and potential traps. If a consumer expends a lot of her limited attention on understanding the products she purchases in detail, then she can do less comparison shopping, lowering competition between firms. Regulating secondary product features—such as certain components of the price or safety of a product, or the working conditions of a job—then enhances competition because it frees consumers from worrying about the regulated features and thereby allows them to do more comparison shopping. Our mechanism is operational under a variety of auxiliary assumptions, creating a stark contrast to the classical view that regulations—especially contract and price regulations—just hinder the functioning of markets. We also show that the benefits of regulating one market may manifest themselves in other markets, and that in order to have a non-trivial pro-competitive effect, the regulations in question must be sufficiently broad in scope.

We begin in Section 2 by illustrating the competition-inducing power of regulation through a simple example. We assume that firms with identical marginal costs of production sell homogeneous products to consumers looking to buy at most one item. Each firm can split the price a consumer must pay for its product into two additive components, a more salient headline price and a less salient additional price. For instance, the total price a consumer pays for a mutual fund is determined by the front load as well as the management fee, and the total price a consumer pays for an appliance is determined by the appliance’s price as well as its energy efficiency. To isolate the key tradeoff in allocating attention in the sharpest possible way, we posit that a consumer can either “study” both the headline and additional prices of one firm, or “browse” only the headline prices of two firms. Within their attentional constraints, consumers choose their search strategies optimally.

In this market, firms charge the monopoly price to all consumers who purchase. Intuitively, consumers must study to guard against price gouging, so they do not have sufficient capacity to meaningfully compare products, eliminating competition. Now consider a cap on the additional price that (for the sake of illustration) is above firms' equilibrium additional prices. We interpret the cap as any regulation—such as a minimum safety standard for physical products or a restriction on certain fees for financial products—that limits how much consumers can be hurt by hidden features after agreeing to purchase. In a classical model, such a price cap would be irrelevant both because it is not binding, and because it does not restrict a firm's total price at all. In our model, in contrast, the cap induces perfect competition: it is now safe for consumers to redirect their attention from studying to browsing, leading firms to compete. Importantly, for this logic to work, the cap must apply to the additional price and *not* the total price, even though it is ultimately the total price that consumers (and firms) care about. A cap on the total price does not prevent firms from using the additional price to price gouge consumers, so it does not make browsing safe.

In the above example, consumers buying a product cannot avoid paying the product's additional price. Starting in Section 3, we turn to the (analytically more complicated) situations in which consumers can avoid the additional price. We modify our model by assuming that beyond choosing its headline and additional prices, a firm specifies a condition under which the additional price is not charged, and studying allows a consumer to learn this condition as well. Furthermore, we distinguish two types of consumers: low-value consumers, for whom fulfilling any condition is costless, and high-value consumers, for whom fulfilling most conditions is too costly. In the context of mobile phones, for instance, the headline and additional prices could be the monthly fee and the fees for extra services (e.g., data above the plan limit, roaming), respectively, with the condition specifying exactly what usage is covered in the monthly fee. Since high-value consumers are less willing to abide by restrictions on usage, it is more costly for them to avoid the additional price.<sup>1</sup>

In Section 4, we identify outcomes when a regulation capping the additional price is in place.

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<sup>1</sup> While our model makes some stylized assumptions, we discuss a number of modifications that (we show) do not affect the main insights. As in the case of a consumer who carefully reads her unconventional mortgage contract and still falls for some traps, low-value consumers may be naive about their ability to avoid the additional price; and as in the case of rich consumers holding a high bank-account balance and therefore never paying an overdraft fee, high-value consumers may automatically avoid the additional price. Furthermore, the consumer may be able to observe further prices at an increasing positive cost; and studying and browsing may occur in different markets.

In equilibrium, firms charge the maximum additional price. Since high-value consumers prefer not to avoid the additional price, for the range of equilibrium headline prices they browse. More subtly, we show that in equilibrium low-value consumers always study and avoid the additional price, as this can save them more money than browsing in the hope of finding a lower headline price. These search decisions in turn imply that the average price consumers pay is *increasing* in the share of low-value consumers. Although high-value consumers pay a higher average price than low-value consumers, their browsing spurs competition and thereby lowers prices—with the latter indirect effect dominating the former direct effect. This prediction helps explain the finding that consumers in lower-income neighborhoods pay higher prices for various goods and services, including mortgages, insurance, and cars (Fellowes, 2006, Agarwal et al., 2016b). Further evidence supports the mechanism of our model as well: observers argue that lower-income consumers face higher prices because they do less comparison shopping (Engel and McCoy, 2002, Agarwal et al., 2016b), while other researchers document that lower-income consumers shop more carefully, and buy the same products at lower prices, at the stores they do frequent (Aguiar and Hurst, 2007, Broda et al., 2009).

In Section 5, we return to analyzing the effects of various regulatory changes. Replicating the logic from our example, we show that deregulation lowers competition: if there is no cap on the additional price, then each firm becomes a local monopolist. Motivated by the suggestions of Barr et al. (2008) and Thaler (“Mortgages Made Simpler,” New York Times, July 4, 2009), we also ask what happens if the social planner standardizes the conditions under which an additional price can be charged, and deviation from these terms requires consumer consent. Fixing prices and consumers’ search behavior, this “plain-vanilla” regulation has no effect—high-value consumers pay and low-value consumers avoid the additional price. Yet because low-value consumers can now simply not consider alternatives to the plain-vanilla product, they can browse, inducing perfect competition between firms.

In Section 6, we extend our baseline model to many markets. We assume that there are  $N$  identical duopoly markets, and consumers wish to make one purchase in each market. After seeing one headline price in each market, a consumer can make  $K \leq N$  other observations of her

choice, with one observation being either a headline price or an additional price plus condition. We establish that our baseline result that low-value consumers study while high-value consumers browse extends to this economy, so that the average price is still increasing in the share of low-value consumers. And just like in our basic model, introducing a plain-vanilla regulation in all markets creates perfect competition everywhere. We also find, however, that the effects of regulation are highly non-linear in the number of regulated markets. Regulating one or a few markets does have the direct effect of allowing low-value consumers to avoid the additional price in the regulated markets. Furthermore, because low-value consumers can turn their attention to other markets, some indirect benefits manifest themselves in all markets, so that evaluating the regulations by focusing solely on the regulated markets underestimates the benefits. Nevertheless, these limited regulations do not affect competition in the headline price, so their impact is relatively modest. But once the regulations are sufficiently broad (in our model, they extend to at least  $N - K + 1$  markets), they suddenly create perfect competition in all markets, suggesting that our framework calls for an overarching legal principle rather than isolated interventions.

Our insight that regulation of secondary product features improves the functioning of markets is of course in stark contrast with the classical view that regulations—especially of contracts, whose role is thought to be in a large part to overcome market failures (Shleifer, 2011)—tend to create deadweight loss. Our results also run counter to the concern—expressed in different forms in both law (Klick and Mitchell, 2006, 2016) and economics (Fershtman and Fishman, 1994, Armstrong et al., 2009)—that consumer-protection policies are prone to lower welfare by undermining consumers’ incentives to learn and protect themselves. In our model, the opposite is the case: consumer protection can increase welfare not only through its direct effect, but also by allowing consumers to substitute effort from meaningless to meaningful learning activities, in the process enhancing competition as well.

Our framework provides to our knowledge novel justifications for some existing regulations and other legal arrangements. Indeed, under our view one reason that developed markets often function better than developing markets may be the heavy regulation of products and contracts. For instance, in developed countries the safety of consumer products is heavily regulated, and consumers

are often further protected from ex-post harm by strict liability regimes. As another specific example, we discuss the European Union’s principle on unfair contract terms, which effectively prohibits standard business-to-consumer contracts from using provisions that are too unclear or surprising relative to how things are normally done, and that are too disadvantageous to the consumer. The limit on the extent to which firms can introduce extra charges in the small print is consistent with our cap on the additional price. The generality of the principle is consistent with our result that the regulation must be sufficiently broad in scope. And the fact that the principle applies to individual terms rather than the entire transaction is consistent with our insight that the additional price rather than the total price must be regulated.<sup>2</sup>

In Section 7, we discuss related literature. For a comparison to previous research, consider a special case of our model in Section 2 in which we start from a symmetric pure-strategy no-regulation equilibrium with monopoly prices. If the social planner imposes a cap on the additional price that equals the pre-regulation additional price, then firms respond by charging an unchanged additional price but a much lower, competitive headline price. This makes clear that our argument for regulation is substantively different from existing ones. Some research (Ronnén, 1991) has argued that making products more substitutable through regulation can increase competition. But in our example, products are identical in all aspects both with and without regulation. The literature on choice complexity (e.g., Spiegler, 2016) emphasizes the importance of price comparability for competition. But in our example, there is no sense in which prices have become simpler to understand. And a basic insight of the extensive literature on search is that decreasing search frictions increases competition. But in our example, it has not become easier to search a product fully. Indeed, due to its novel mechanism based on the tradeoff between browsing and studying, our model yields several insights missing from previous research: we provide a formal argument as to why secondary features rather than the total price (or value) should be regulated, why interventions such as safety regulations, strict liability, or the fair contracts principle are pro-competitive, and why the breadth of regulation is an important determinant of its effectiveness. We conclude in Section 8.

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<sup>2</sup> We also emphasize, however, that our arguments must be balanced against classical concerns regarding regulation, so that our results are not intended to endorse the indiscriminate regulation of secondary features.

## 2 Main Mechanism: Unavoidable Additional Price

In this section, we illustrate the core mechanism behind our policy insights through a simple case of our model. There are  $I \geq 2$  firms selling a homogeneous product with cost  $c$ . Each firm  $i$  chooses a headline price  $f_i \in \mathbb{R}$  and an additional price  $a_i \geq 0$ . Consumers are looking to buy at most one product, and value all products at  $v > c$ . If a consumer purchases product  $i$ , she pays a total price of  $f_i + a_i$ .<sup>3</sup> Each consumer sees the headline price of one randomly chosen firm automatically. A consumer assigned to firm  $i$  can then learn exactly one more thing: either the additional price  $a_i$  of firm  $i$ —which we refer to as “studying”—or the headline price  $f_j$  of a randomly chosen rival  $j$ —which we refer to as “browsing.” To rule out fragile Diamond-paradox-type equilibria, we assume that some (potentially small fraction of) consumers browse. A consumer can only buy from a firm if she has seen that firm’s headline price. We look for perfect Bayesian equilibria.

The above model applies to situations in which the additional price is unavoidable. In the market for mutual funds, for instance, all investors pay not just the front load, but also the management fee charged by a fund. In the market for electric appliances, all consumers are affected not just by the purchase price, but also by the energy efficiency of a product. And in the labor market, all workers are affected not just by the wage, but also by the working conditions—such as safety—of a job. Furthermore, in all of these cases the core price of the product—the front load, appliance price, or wage—is more easily observable to consumers because it is paid earlier and/or it is easier to figure out upon looking at the product.

Although the market features homogeneous firms engaged in price competition, it does not work for consumers:<sup>4</sup>

**Proposition 1.** *In any equilibrium in which a positive share of consumers purchase, these consumers pay a total price of  $v$ . Such equilibria exist.*

In equilibrium, each firm acts as a monopolist, extracting all rents from all consumers who purchase.

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<sup>3</sup> This formulation corresponds most directly to a situation in which  $a_i$  is a fee or price. But the logic of our results applies to any secondary feature over which the firm and consumer have conflicting interests. An unsafe product, for instance, benefits the firm in the form of cost savings and hurts the consumer in the form of potential harm.

<sup>4</sup> Following common convention, in stating and discussing our propositions we ignore the possibility that firms choose suboptimal prices with probability zero.

Intuitively, consumers who purchase must study, otherwise firms could raise the additional price on them at will. With consumers being on guard against price gouging, they do not have sufficient capacity to meaningfully compare products, so there is no competition between firms. To make matters worse, consumers may inefficiently (browse and) give up on purchasing, and firms have no way of inducing them to change their minds.

To illustrate the attention-leveraging power of regulation, consider a symmetric pure-strategy equilibrium consistent with Proposition 1 in which all firms charge prices  $f, a$  satisfying  $f + a = v$ . Suppose that the social planner imposes a cap of  $\bar{a} \geq 0$  on the additional price, so that firms must choose  $a_i \in [0, \bar{a}]$ . We interpret the cap as any legal limit on the extent to which consumers can be hurt after agreeing to purchase. This interpretation is consistent with regulations specifying minimum safety standards for physical products as well as regulations addressing the working conditions of jobs. It is also consistent with a tort regime of strict liability, in which consumers can obtain compensation for harm through legal action. Although our result holds for any  $\bar{a} \geq 0$ , it is worth pointing out the special case  $\bar{a} > a$ . In a classical market in which consumers observe all prices, and even in a classical search environment in which consumers observe all characteristics of a searched product, this price cap would be ineffective for two reasons: (i) it is not binding; and, independently of whether it is binding, (ii) it does not restrict a firm's total price at all. In our model, in contrast, the cap turns firms from local monopolists to perfect competitors:

**Proposition 2.** *In the unique equilibrium, all consumers buy at a total price equal to  $c$ .*

The competition-inducing effect of regulation arises from two mechanisms. First, regulation makes browsing more effective in selecting between products. In an unregulated market, any cut in the headline price can be undone by an increase in the additional price, so the cut is meaningless for a consumer not observing the additional price. In a regulated market, however, there are cuts in the headline price that cannot be fully undone by an increase in the additional price, so that the headline price becomes a useful signal of the total price. This mechanism is crucial in undermining the no-regulation equilibrium above.<sup>5</sup>

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<sup>5</sup> Suppose all competitors of firm  $i$  charge the prices  $f, a$  satisfying  $f + a = v$ , but firm  $i$  deviates and instead chooses  $f_i = v - \bar{a} - \epsilon$ ,  $a_i = \bar{a}$  for some  $\epsilon > 0$ . Then, consumers browsing firm  $i$  realize that its total price is at most  $f_i + \bar{a} = v - \epsilon$ , so that they all buy from firm  $i$ . For a sufficiently small  $\epsilon$ , therefore, firm  $i$ 's deviation is profitable.



The first mechanism operates even without changing consumers’ search behavior. Our focus in this paper is on the second, more central mechanism: regulation changes consumers’ search behavior, redirecting it from studying to browsing. Indeed, in equilibrium consumers know that the additional price is at the maximum level, so—not needing to study—they browse. This mechanism is what enforces the perfectly competitive outcome in Proposition 2.

Note that the regulation induces firms to raise their additional prices to the cap. This reaction is consistent with arguments that a price cap can create a harmful focal price for firms, leading the regulation to backfire. Despite creating such a focal price, however, in our model the regulation is strongly pro-competitive.<sup>6</sup>

A potential example of the above type of regulation is the German Civil Code’s as well as European Union’s principle on unfair terms in standard business-to-consumer contracts. This principle limits additional charges in the small print by effectively prohibiting provisions that are too unclear or surprising relative to how things are normally done, and that are too disadvantageous to the consumer.<sup>7</sup> Our model says that such a legal principle is not only a matter of ensuring fairness—which is how the principle is couched—but also a matter of facilitating competition.

Interestingly, the principle on unfair contract terms explicitly states that it applies only to individual provisions in the contract, and *not* to the transaction as a whole.<sup>8</sup> From a classical perspective, it may be puzzling why the social planner insists on regulating the fairness of individual terms rather than the fairness of the transaction as a whole; after all, it is the entire transaction that both parties care about. We show, however, that in our framework this part of the principle makes sense as well. In our model, the variable that summarizes parties’ surpluses from the exchange is

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<sup>6</sup> The extreme result that a non-binding, even arbitrarily high, cap on the additional price increases competition is unrealistic and not robust to reasonable modifications of our model. First, in our model of Section 3 only a binding cap on the additional price is robustly competition-enhancing. Second, a high cap is only consistent with competition if a high additional price can be competed away by decreases in the headline price, and for many reasons this may not be the case (Heidhues and Kőszegi, 2018).

<sup>7</sup> See Sec. 305c and 307 of the German Civil Code (with Sec. 308-9 spelling out Sec. 307 in more detail) and Articles 3, 5, and 6 of directive 93/13/EEC of the Council of the European Communities. The documents are available at [https://www.gesetze-im-internet.de/englisch\\_bgb/englisch\\_bgb.html#p0925](https://www.gesetze-im-internet.de/englisch_bgb/englisch_bgb.html#p0925) and <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0013:en:HTML>, respectively.

<sup>8</sup> “Assessment of the unfair nature of the terms shall relate neither to the definition of the main subject matter of the contract nor to the adequacy of the price and remuneration, on the one hand, as against the services or goods supplies in exchange, on the other” (Article 4.2 of directive 93/13/EEC of the Council of the European Communities).

the total price consumers pay. Hence, we consider a cap  $\bar{t} > c$  on the total price rather than the additional price:

**Proposition 3.** *In any equilibrium in which a positive share of consumers purchase, these consumers pay a total price of  $\min\{\bar{t}, v\}$ . Such equilibria exist.*

Regulating the total price has no competition-enhancing effect. As in the unregulated market, any cut in the headline price can be offset by an increase in the additional price, so browsing consumers cannot meaningfully compare prices. It is the additional price—the secondary feature—that the social planner must regulate to encourage competition.<sup>9</sup>

### 3 Avoidable Additional Price

In this section, we introduce our main model, considering situations in which the additional price can be avoided, and beginning with a market in which there is a cap on the additional price. Such a cap is consistent with regulations that limit the additional fees imposed for bank accounts, credit cards, investments, and other products and services.

#### 3.1 Formal Setup

There are  $I \geq 2$  firms selling a homogeneous product with cost  $c$ . Each firm  $i$  chooses a headline price  $f_i$ , an additional price  $a_i \in [0, \bar{a}]$ , and a condition  $\gamma_i \in [0, 1]$  that consumers must fulfill to avoid the additional price. Consumers are looking to buy at most one product. If a consumer purchases product  $i$ , she pays  $f_i$ . In addition, she chooses a usage pattern  $\tilde{\gamma} \in [0, 1]$ , and pays  $a_i$  if  $\tilde{\gamma} \neq \gamma_i$ .

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<sup>9</sup> Many audience members have raised the possibility that price-comparison websites serve a competition-enhancing role that obviates the need for regulation. We take the perspective that these tools can only be used to compare headline prices. (Consistent with such a perspective, Ellison and Ellison (2009) document that sellers on a price-comparison website charge add-on prices that only become apparent once the consumer visits the seller’s own site.) While this may have some effect on competition, in our framework it is clearly not a full solution. Think of a price-comparison site as allowing consumers to browse *all* headline prices in the unregulated market above (while still being able to observe only one additional price). Without a cap on the additional price, this leaves the result unaffected, as it still does not allow consumers to compare total prices.

There are two types of consumers, both of whom have an outside option with utility zero. A low-value consumer's utility from the product is  $v_L > c$ , and her cost of fulfilling any condition is zero; this means that her utility from purchasing product  $i$  is  $v_L - f_i - \mathbb{I}(\tilde{\gamma} \neq \gamma_i)a_i$ , where  $\mathbb{I}$  is the indicator function. A high-value consumer's utility from the product is  $v_H$ , and she has a person-specific  $\gamma^* \sim U[0, 1]$  such that  $\tilde{\gamma} = \gamma^*$  has cost zero, but any  $\tilde{\gamma} \neq \gamma^*$  has cost greater than  $\bar{a}$ ; this means that her utility from purchasing product  $i$  is  $v_H - f_i - \mathbb{I}(\tilde{\gamma} \neq \gamma_i)a_i - \mathbb{I}(\tilde{\gamma} \neq \gamma^*)k$ , with  $k > \bar{a}$ . We suppose that  $v_H \geq v_L + \bar{a}$ , so that high-value consumers get a weakly higher consumption benefit from any offer. The share of low-value consumers is  $\alpha \in (0, 1)$ .

Each consumer sees the headline price of one firm automatically, with a share  $1/I$  of both low-value and high-value consumers seeing firm  $i$ 's headline price. A consumer assigned to firm  $i$  can then learn either the additional price  $a_i$  and condition  $\gamma_i$  of firm  $i$  (studying) or the headline price  $f_j$  of a rival  $j$  selected randomly and with equal probability from the other firms (browsing).<sup>10</sup> A consumer can only buy from a firm if she has seen that firm's headline price.

We look for perfect Bayesian equilibria, defined in our setting as follows. A firm's strategy is a triplet consisting of the distribution  $G_i(\cdot)$  of its headline price, the set of distributions  $A_i(\cdot|f_i)$  of its additional price conditional on each  $f_i \in \mathbb{R}$ , and the set of distributions  $\Gamma_i(\cdot|f_i, a_i)$  of its terms conditional on each  $f_i \in \mathbb{R}, a_i \in [0, \bar{a}]$ . A firm's equilibrium triplet maximizes expected profits given the behavior of consumers and competitors. A consumer's beliefs are derived from firms' equilibrium strategies using Bayes' Rule whenever possible, and the consumer's strategy maximizes expected utility at each information set.

Furthermore, we impose two mild equilibrium-selection assumptions. First, some (potentially small fraction of) high-value consumers browse. This assumption allows us to rule out fragile Diamond-paradox-type equilibria, such as the outcome when all firms set  $v_L, \bar{a}$  and all consumers study.<sup>11</sup> Second, if consumers observe an off-equilibrium  $f_i$ , then they believe that firm  $i$  sets  $A_i$

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<sup>10</sup> To abstract from other issues, we assume that all consumers have the same set of search strategies available, implicitly imposing that they have the same search costs. The possibility that low-value and high-value consumers face different search costs does not seem to interact with the effects we identify. In addition, it is unclear which type faces higher search costs. For instance, Kaplan and Menzio (2015) document that unemployed consumers shop more than employed consumers, but Mullainathan and Shafir (2013) suggests that low-income consumers have higher search costs because they lead busier lives.

<sup>11</sup> An alternative equilibrium-selection assumption we could use for the same purpose is that a small fraction of consumers are fully informed.

and  $\Gamma_i$  optimally for some consumer groups (i.e., studying or browsing high-value or low-value consumers) and cannot at the same time set  $A_i$  and  $\Gamma_i$  optimally for one more consumer group.<sup>12</sup> This assumption allows us to argue that if a consumer observes an off-equilibrium cut in the headline price, then she does not infer good news about  $a_i$  and  $\gamma_i$  and thereby conclude that the value of studying has decreased.

To see how the ingredients of our model can be mapped to an application, consider mobile phones. We can think of  $f_i$  as the monthly fee,  $a_i$  as the additional charges for roaming, extra minutes or data, or other services, and  $\gamma_i$  as the specifics of what usage is covered in the monthly fee. While low-value consumers are willing to abide by restrictions on usage, high-value consumers prefer flexibility in when, where, and how they use their phones. The cap  $\bar{a}$  on the additional price could come from regulation or the threat of regulation or legal action. A similar logic applies to many other products with add-ons that primarily high-income consumers tend to use.

We fully analyze this main model, as well as the effects of deregulating the additional price, by considering both the existence and the uniqueness of equilibria. When analyzing alternative models, however, we do not consider the technically difficult issue of uniqueness, but only look for equilibria of the forms we have found in our main model.

### 3.2 Discussion of Modeling Assumptions

To set up a tractable baseline model of the tradeoff between browsing and studying, we have made a number of particular assumptions above. As a robustness exercise, in Appendix A we examine the implications of many modifications to our assumptions. Since many applications we discuss are better described by one of these alternatives than by our baseline model, we briefly mention the alternatives here.

*Shape of Attention Costs.* Our model captures limited attention in an extreme form: by assuming that the consumer can observe two prices for free, and observing any other price is infinitely costly. As a less extreme way of capturing convex attention costs, we solve a model in which

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<sup>12</sup> Our second equilibrium-selection assumption is closely related to the notion of wary beliefs proposed by McAfee and Schwartz (1994) and adapted to a context similar to ours by Armstrong (2015), whereby consumers who observe out-of-equilibrium offers suppose that firms chose the unobserved features of the offer optimally. As our proof makes clear, in our setting these beliefs coincide with what McAfee and Schwartz term passive beliefs.

observing any price after the first two has positive and increasing—but finite—cost.<sup>13</sup>

*Consumer Understanding.* While we have assumed that consumers are rational, we also analyze the implications of a plausible form of consumer naivete: the possibility that consumers who study and attempt to avoid the additional price nevertheless incur unexpected charges. For example, a borrower who carefully looks at her unconventional mortgage contract and believes that she understands everything may still fall for some traps.

*Avoiding the Additional Price.* We have also assumed that high-value consumers—whom we interpret as higher-income consumers—find it more costly than low-value consumers to avoid the additional price. But we consider a version of the opposite case as well, analyzing situations in which high-value consumers avoid all or part of the additional price without any effort. For instance, because a high-income consumer has little trouble repaying her credit-card balance every month, she may rarely pay interest or late fees; and because she always carries high bank-account balances, she may never pay overdraft fees.

Beyond being economically relevant, this extension helps clarify the mechanism behind our result on high prices in low-income neighborhoods (Section 4). The logic of the result hinges on the assumption that low-value consumers want to avoid additional prices, *and* that they need to study to do so. The assumption on the difference in valuations between high-value and low-value consumers—which we made only to ensure that both types purchase—and the assumption that high-value consumers do not want to avoid the additional price, are unimportant. Indeed, if high-value consumers avoid all of the additional price for free and  $v_H = v_L > c$ , then our results apply unchanged.

*Tradeoff between Browsing and Studying.* It is plausible that the markets in which studying and browsing occur are different, so that studying in one market crowds out browsing in another market. For instance, a consumer may study the local supermarket’s sales and coupons to save on food, but as a result she has less time to search for the cheapest bank account or to consider whether to switch her energy supplier. A formal two-market example is the following. One market is as above, but it is monopolistic, and parameters are such that it is optimal for the monopolist to

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<sup>13</sup> We also briefly discuss issues that arise when observing one or both of the first two prices is costly. These parallel issues in existing search models.

sell to all consumers at prices  $f = v_L, a = \bar{a}$ . In the other market, there are  $I$  firms, all consumers derive the same value from the product, and each firm can only charge a headline price. Consumers see a headline price in each market, and can either study in the monopolistic market or browse another firm in the oligopolistic market.

*The Benefit of Studying.* In our model, a major benefit of studying is in learning how to avoid the additional price, enabling the consumer to then avoid the additional price. In some situations, similarly attention-draining behaviors are aimed directly at avoiding the additional price. For instance, a consumer presumably does not need to find out how to use a money order instead of a check to avoid overdraft charges, but going through the steps nevertheless requires attention. This leads to an equivalent model to ours.<sup>14</sup>

## 4 Baseline Equilibrium: High Prices for Low-Income Populations

Our model has a unique equilibrium outcome with the following properties:<sup>15,16</sup>

**Proposition 4.** *In equilibrium, all firms charge an additional price of  $\bar{a}$ . Low-value consumers study and avoid paying  $\bar{a}$ , while high-value consumers browse and incur  $\bar{a}$ . Firms choose headline prices according to a unique continuous distribution with support  $[f_{min}, f_{max}]$ , and at each price earn expected profits equal to  $\alpha(f_{max} - c)/I$ . Furthermore, there exists an  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  for  $\alpha \geq \alpha^*$  and  $f_{max} = E[f] + \bar{a} < v_L$  for  $\alpha < \alpha^*$ . The average total price that consumers pay is strictly increasing in  $\alpha$ .*

To take advantage of browsing consumers, firm  $i$  sets  $a_i = \bar{a}$ , and to make sure that a consumer

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<sup>14</sup> While our stylized models apply to many economic situations, we note that there are also settings in which high-income consumers are likely to study more than low-income consumers, leading to higher margins in higher-income neighborhoods. As a case in point, if studying helps a consumer determine which of multiple horizontally differentiated products she likes, and a high-income consumer—such as a rich wine connoisseur—has more particular tastes, then she studies more. Such instances, however, seem economically less important than those above.

<sup>15</sup> To avoid repeated clumsy expressions, we simplify statements of the form “a consumer incurs the additional price with probability one” by dropping the qualifier “with probability one.” The difference arises due to the zero-probability event that a consumer chooses the usage pattern  $\gamma_i$  without studying.

<sup>16</sup> Baye et al. (1992) show that the classic search model of Varian (1980) has infinitely many equilibrium outcomes when there are more than two firms. With the exception of the symmetric one, all of these equilibria include mass points at the consumers’ reservation price for at least one firm. As we show in the proof of Lemma 4, equilibria with mass points do not exist in our setting because browsing high-value consumers see two headline prices, whereas in Varian’s model informed consumers see all prices.

is only guaranteed to avoid  $a_i$  by studying, it randomizes  $\gamma_i$ . Since high-value consumers prefer not to avoid the additional price, they browse for any equilibrium headline price.<sup>17</sup> Less obviously, in equilibrium low-value consumers always prefer to study. For a rough intuition, note that since all firms set  $a_i = \bar{a}$  for any  $f_i$ , a consumer prefers to browse if and only if the headline price she observes is sufficiently high. Now consider the firm that charges the highest equilibrium headline price, supposing that no other firm charges the same price with positive probability. If at this price low-value consumers preferred to browse, then—with all consumers browsing—the firm would lose all consumers to lower-priced competitors with probability one. In an effect reminiscent of the “competition for consumer inattention” in De Clippel et al. (2014), the firm therefore lowers its headline price to the range where low-value consumers study.<sup>18</sup>

The differential behavior between the consumer types leads to an economically relevant main prediction: that the average price consumers pay is *decreasing* in the share of high-value consumers. On the one hand, high-value consumers—paying the additional price—pay a higher average price than do low-value consumers, so they have a direct positive effect on the average price consumers pay. On the other hand, high-value consumers browse and thereby spur competition, so they have an indirect negative effect on the average price firms charge. Proposition 4 establishes that the latter effect always dominates the former effect.

The detailed logic of this result is as follows. The fact that low-value consumers study implies that if  $\alpha$  is sufficiently high, a firm can guarantee itself the low-value consumers assigned to it by setting  $f_i = v_L$ . Similarly to Varian (1980), this option generates a “profit base” that ties down firms’ equilibrium profit level. Since the profit base is given by *low-value* consumers, an increase in their share raises profits.

If  $\alpha$  is sufficiently low, the competition for consumer inattention described above also comes

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<sup>17</sup> A high-value consumer prefers to browse whenever it observes  $f_i < v_H - \bar{a}$ , since she is then assured that the product is not too expensive to buy. Our proof in turn establishes that in equilibrium no firm charges an up-front price above  $v_L \leq v_H - \bar{a}$ . For such high up-front prices, low-value consumers do not buy, so firms must earn profits from high-value consumers. But because a small fraction of high-value consumers browse, there cannot be a mass point in the total price, which implies that when observing an up-front price corresponding to the highest total price, high-value consumers strictly prefer browsing, and hence for such up-front prices a firm earns zero profits.

<sup>18</sup> Similarly, in classic sequential search models (e.g. Stahl, 1989, Janssen et al., 2005) equilibrium prices are just low enough to discourage consumers with positive search costs from searching a second product. This logic also drives the robustness of our insights to allowing consumers to search additional prices at positive costs: such search costs work like an additional attention constraint that must be satisfied in equilibrium (see Appendix A).

into play. Again similarly to Varian, the dual objective of exploiting price-insensitive low-value consumers and attracting price-sensitive high-value consumers leads firms to select a random headline price. When there are many high-value consumers, the motive to compete for them is strong, so firms' expected headline price is quite low. If a firm quoted a headline price of  $v_L$ , therefore, a low-value consumer would be better off browsing and choosing a competitor. This threat of losing low-value consumers reduces the price determining the profit base to below  $v_L$ .

The main prediction of Proposition 4 helps explain evidence that consumers in lower-income neighborhoods pay higher prices for various goods and services, including mortgages, insurance, cars, mobile phones, and energy (Fellowes, 2006, Hogan, 2016). While other factors (e.g., the higher costs of doing business in lower-income neighborhoods) surely contribute to this phenomenon, they are unlikely to provide a full explanation, especially since they may well point in the opposite direction (the costs of doing business are presumably often lower in lower-income neighborhoods).<sup>19</sup> Furthermore, some evidence supports the mechanism of our model. Consistent with our prediction that low-value consumers do less browsing, several authors have noted that the high prices in lower-income neighborhoods arise in part because lower-income consumers do less comparison shopping (Engel and McCoy, 2002, Fellowes, 2006, Ofgem, 2014, Agarwal et al., 2016b). Yet consistent with our prediction that low-value consumers do more studying, Aguiar and Hurst (2007) and Broda et al. (2009) find that lower-income consumers spend less on the same items than do higher-income consumers living in the same area, primarily by shopping more frequently and taking greater advantage of discounts. By the same token, Blank (2008) argues that low-income consumers use cumbersome alternative financial services in part to avoid the fees associated with bank accounts, for instance paying bills with money orders instead of checks to avoid overdraft charges.

A reassuring thought might be that since selling in low-income neighborhoods is more profitable, firms are more likely to enter such neighborhoods, lowering prices for consumers after all. A new firm, however, must not only enter the market, it must be found by consumers—and it seems natural to assume that a new entrant is in a disadvantageous position when trying to attract consumers

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<sup>19</sup> For instance, Agarwal et al. (2016b) document that lenders sold overpriced mortgages to a large number of highly qualified borrowers, and were more likely to do so for borrowers from lower-income neighborhoods. The higher prices were not justified by borrowers' previous qualifications or subsequent default rates. This finding is part of a broader conclusion that low-income borrowers received very unfavorable mortgage terms (e.g., Engel and McCoy, 2002).



with limited attention. In Appendix B, we formulate a model that captures this disadvantage, and establish that when the share of low-value consumers is high, entry is relatively unprofitable for the same reason—lack of comparative search by consumers—that being in the market is profitable. Worse, if entry occurs, it increases the average price consumers pay. With the entrant in the market, incumbents reorient their pricing strategy toward exploiting low-value consumers, reducing overall competition in the market. For instance, this logic provides one account of why liberalization in the UK energy market led to high prices: entrants attracted consumers looking to switch, leading legacy suppliers to raise prices on their remaining, disproportionately non-switching (and disproportionately lower-income) consumers (Ofgem, 2014). Hence, entry is unlikely to do much for populations with many low-value consumers.

## 5 The Effects of Regulation

We now return to the main message of our paper: that regulation can lead consumers to substitute their search efforts toward browsing, enhancing competition. We demonstrate this as well as a number of additional insights by analyzing how changes in regulations—in both the permissive and restrictive directions—affect the equilibrium we discussed in Section 4.

### 5.1 Competition and Regulation: Results

*Deregulation Leads to Monopoly.* To make our basic point, we ask what happens in the model of Section 3.1 without regulation, modifying the model in three ways. First, crucially, we assume that there is no cap on the additional price. Second, for simplicity, we posit that high-value consumers cannot avoid the additional price at any cost. Third, we impose another mild equilibrium-selection assumption: that whenever a consumer type is indifferent between browsing and studying, she browses with a fixed probability. This assumption allows us to rule out unreasonable coordination by consumers on a variable that is payoff-irrelevant for themselves.

**Proposition 5.** *In any equilibrium in which both consumer types buy with positive probability, firms charge  $f_i = v_L$  and  $a_i = v_H - v_L$ , and such an equilibrium exists.*

Deregulation leads to a total collapse in competition: without a cap on the additional price, each firm acts as a monopolist, using the two prices to perfectly price discriminate between—and extract all rents from—consumers who purchase. As in Proposition 1, in equilibrium consumers must study to guard against price gouging, so they do not comparison shop, and therefore firms do not compete. Furthermore, there are also equilibria in which all high-value consumers browse and then do not buy, for instance because they believe that firms have priced them out of the market ( $a_i > v_H - v_L$ ). In such situations, regulation not only lowers prices, but also increases efficiency.

A plausible example of an insufficiently regulated market in the spirit of Proposition 5 is the pre-crisis subprime mortgage market. Bar-Gill (2009) argues that the complexity of the fees lenders could impose rendered it exceedingly difficult to compare products, so borrowers may have even rationally decided not to comparison shop. Despite the seemingly competitive nature of the market by conventional measures of concentration, therefore, lenders acted as local monopolies.

The comparison of Propositions 4 and 5 establishes that similar to our main insight in Section 2, regulation of additional fees can increase competition by changing consumer search behavior. Unlike in Section 2, however, this result hinges on the regulation being sufficiently strict. Our baseline model requires that  $\bar{a} \leq v_H - v_L$ , i.e., it requires a cap on the additional price that is binding when one starts from the equilibrium of Proposition 5. If  $\bar{a} > v_H - v_L$  and  $\alpha > \alpha^*$ , then the equilibrium in Proposition 4 does not survive, as high-value consumers quoted two prices near  $v_L$  would not purchase. For  $\bar{a}$  sufficiently close to  $v_H - v_L$ , there is an equilibrium with a similar structure, but it generates lower consumer value both because high-value consumers might not purchase and because consumers who do purchase pay a higher average price.<sup>20</sup> And for sufficiently high  $\bar{a}$ , even this type of equilibrium fails to exist.<sup>21</sup> At the same time, the equilibrium in Proposition 5 survives for any  $\bar{a} > v_H - v_L$ . These observations imply that only a binding cap on the additional price

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<sup>20</sup> In such an equilibrium, firms (beyond choosing the additional price  $\bar{a}$  with probability 1) charge the headline price  $v_L$  with positive probability, and with the complementary probability charge a headline price continuously distributed on  $[f_{min}, v_H - \bar{a}]$ . The latter part of the distribution is similar to that in Proposition 4 and ensures that firms earn  $\alpha(v_L - c)/I$  in expectation for all headline prices. If a high-value consumer samples two firms with headline price  $v_L$ , then she does not purchase. Since firms earn the same expected profit as in Proposition 4 but consumers do not always purchase, the expected total payment of a consumer conditional on purchase must be higher than in Proposition 4.

<sup>21</sup> For sufficiently high  $\bar{a}$ , a firm charging a headline price of  $v_H - \bar{a}$  makes losses, and hence trying to attract high-value consumers cannot be worth it.

( $\bar{a} \leq v_H - v_L$ ) is robustly competition-enhancing, and higher caps may produce smaller gains even when they do have an effect. Still, the general insight that the regulation can have a large positive indirect effect holds: a binding regulation can have a much larger total impact on prices than its direct impact on the additional price.

*Plain-Vanilla Regulation Leads to Perfect Competition.* Completely different regulations can also engage the mechanism of empowering consumer search. As a potentially important example, we consider an intervention in our basic model with a cap  $\bar{a}$  on the additional price. Suppose that the social planner imposes a known default of  $\gamma_d = 0$ , and if a firm wants to choose another  $\gamma_i$ , it must ask consumers to agree, which consumers can refuse without needing to study the offer. Formally, if a consumer purchases, she can select whether condition  $\gamma_d$  or  $\gamma_i$  applies. Roughly consistent with the proposal of Barr et al. (2008), for instance, the government can require lenders to offer a simple “plain-vanilla” mortgage contract, and allow a consumer to refuse other offers without reading them. Holding prices and search behavior fixed, this policy does not affect any outcomes—low-value consumers avoid the additional price, while high-value consumers do not. Nevertheless, the policy has a drastic effect:

**Proposition 6.** *With a plain-vanilla policy, there is an equilibrium in which low-value and high-value consumers pay total prices of  $c - (1 - \alpha)\bar{a}$  and  $c + \alpha\bar{a}$ , respectively, and firms make zero expected profits.*

Low-value consumers stick with the default, and—no longer needing to study to avoid the additional price—they can now browse, inducing perfect competition between firms. Both high-value and low-value consumers benefit from this, but because low-value consumers suffered more from the lack of competition, they benefit more.<sup>22</sup>

In contrast to the above types of regulations, market-educational policies—policies intended to help consumers better understand the products on offer—are likely to have mixed effects. To start, absorbing education requires consumer attention, which may be drawn away from other useful

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<sup>22</sup> First, within a given population, low-value consumers benefit more from the regulation. Without regulation, they obtain the product at a more expensive headline price on average. With regulation, they do so at the same headline price. Second, populations in which the share of low-value consumers is higher also benefit more from the regulation. Without regulation, the average total price consumers pay is increasing in the share of low-value consumers. With regulation, it is constant.

activities. Even ignoring this effect, education can still leave consumers with the need to study, and hence not lead to a better-functioning market. As an example, consider the variant of our model with naive consumers (Appendix A). If education makes naive consumers who are oblivious to the additional price aware of the additional price, it induces them to switch from browsing to studying, leading to a decrease in the competitiveness of the market.

## 5.2 A Pro-Market Case for Regulation: Discussion

The above insights yield a powerful competition-policy-based argument for regulating secondary product features: the right regulations simplify consumers' lives and allow them to do more comparison shopping, exerting a beneficial indirect effect on the functioning of markets. This view contrasts with the common presumption that restrictions on what people can trade—especially restrictions on contracts—create deadweight loss. But the view has some precedent in development economics: Duflo (2012), for instance, argues that regulation actually increases economic freedom by liberating individuals from unnecessary worries, such as those about contaminated drinking water and dangerous medications. Our model formalizes a version of Duflo's argument, and shows that such "liberating regulation" can also result in a better-functioning market. This perspective suggests that part of the reason that markets in the developed world function well is heavy regulation of product and contract features.

Our view also contrasts sharply with the "nanny-state" concern, a common argument against consumer protection and other interventions aimed at improving individuals' decisions and welfare. Just like an overprotective nanny can hurt the long-run health of a child by preventing her from learning where and when to be careful, the argument goes, an overly paternalistic policymaker can hurt consumers by lowering their incentives to protect themselves. Besides being a regular question in seminars, this argument is commonly made in the popular press (e.g., "The avuncular state", *Economist*, April 6th, 2006) as well as scholarship in law (Klick and Mitchell, 2006, 2016) and economics (Fershtman and Fishman, 1994, Armstrong et al., 2009).<sup>23</sup> Our results say that the

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<sup>23</sup> A related argument is made in the behavioral-economics literature on nudges, with researchers pointing out that nudges aimed at improving individual decisions could have unintended side effects in equilibrium (Handel, 2013, Spiegler, 2015).

opposite may well be the case: policies can enhance consumer welfare not only through their direct effect of preventing mistakes, but by their indirect effect of liberating consumers to browse more, in the process enhancing competition as well.

It is worth comparing our main message especially to that of Fershtman and Fishman (1994) and Armstrong et al. (2009), who provide a compelling argument that price caps can lower consumer welfare. In their models, consumers observe the price of only one firm, but can incur a cost to become informed about the prices of other firms. A price cap shrinks price dispersion and thereby reduces consumers' incentive to become informed, decreasing competition. As a result, a relatively high price cap can raise the average price consumers pay.

Qualifying the above insight, our framework suggests that even if a price cap reduces consumer welfare in one market exactly because of the mechanism in Fershtman and Fishman (1994) and Armstrong et al. (2009), consumers may use the attention they save to browse in another market, increasing consumer welfare there. More importantly, we view the above insight as being complementary to ours. In Appendix C, we show that a cap on the *headline price* in our model can have the same price-increasing effect as a cap on the price in the models of Fershtman and Fishman (1994) and Armstrong et al. (2009). Along with our result in Section 2 that a cap on the total price does not work, this implies that the beneficial effect of regulation we have identified applies to regulations of *secondary* features, not to interfering with the core market mechanism.<sup>24</sup>

In most models in this paper, regulation lowers prices and thereby benefits consumers and hurts firms. But in natural variants, firms can also benefit from regulation. As an interesting case in point, consider the variant of our model in which browsing and studying occur in different markets (see Section 3.2), and suppose that there is no cap on the additional price. Clearly, there is no analogue of Proposition 5 in this market: since some high-value consumers browse, there must be competition in the oligopolistic market. Instead, there is an equilibrium with the following properties: (i) price distributions in the oligopolistic market are the same as with regulation; (ii) low-value consumers purchase in both markets, buying from the firm they encounter in the oligopolistic market and studying and avoiding the additional price in the monopolistic market; (iii) high-value

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<sup>24</sup> Of course, in practice it may be difficult to distinguish core prices and secondary features, and our theory does not provide guidance as to how to do so.

consumers browse in the oligopolistic market, and (iv) high-value consumers refrain from buying in the monopolistic market, assuming (correctly) that there is no way for them to safely buy the product. Capping the additional price in the monopolistic market leads high-value consumers to purchase there, so that the monopolistic firm prefers regulation. Intuitively, regulation engenders trust in consumers that the product is safe to buy, benefitting the monopolist.

Two important caveats regarding our policy results are in order. First, one must recognize that learning about and understanding policies requires attention just like learning about and understanding products does. Hence, to really liberate consumers to do more browsing, the regulations motivated by our framework should be simpler to communicate and understand than the market practices they govern, and they are likely to be most effective if distilled into clear, broad principles. Once again, the European Union’s principle on unfair contract terms is a potential practical example: it has extremely broad scope (it applies to any business-to-consumer contract), yet its basic idea is easy to understand.

Second, the message that regulation of additional prices or other secondary features can have a pro-competitive effect must be balanced against classical concerns regarding regulation. For instance, these secondary features may be an efficient response to heterogeneity in consumer preferences, so that regulating them is harmful. To be precise about the tradeoff, it would seem useful to integrate our framework into a model in which possible distortions are explicitly specified. Although a general analysis is beyond the scope of this paper, we give an example of a likely tradeoff in Appendix D: if a consumer needs to study to determine whether she likes the basic or the premium version of a product, then a standardization that bans the premium version enhances competition at the cost of lowering efficiency. But other natural extensions of our model also identify further efficiency benefits of the types of regulations we have considered. If consumers have heterogeneous values, then a decrease in prices brought about by competition can have the classical welfare-enhancing effect of drawing more consumers into the market. And inducing consumers to browse can also facilitate efficiency in matching if consumers have heterogeneous tastes for the basic versions of a product.

## 6 Multiple Markets

Our baseline model posits a single product market, and as a result assumes that the tradeoff between browsing and studying must occur at the product level. In reality, the tradeoff is likely to be relevant only when having to make many purchases: it *is* possible to both browse and study in a single market of one’s choice—but it is *not* possible to do so in all markets relevant to one’s life. To study such situations, in this section we analyze an extension of our model in which the consumer makes purchases in multiple markets, and uses her limited attention to optimally study and/or browse in these markets. We show that our main insights survive, and derive further insights on how the potential benefits of regulating a market manifest themselves, as well as on how these benefits depend on the scale of the regulation.

We build on the model of Section 3. Essentially, we clone the single market in that model multiple times, but for tractability, we also make a few modifications that do not seem to affect the logic of our mechanism. There are  $N$  identical markets of the type described in Section 3.1, with  $I = 2$  firms in each market and each firm operating in one market. There are two types of consumers. High-income consumers are akin to our previous high-value consumers in all  $N$  markets, and low-income consumers are akin to our previous low-value consumers in all  $N$  markets, but we impose that both types of consumers have to purchase in all markets (their utility from not purchasing is  $-\infty$ ). In each market, a consumer sees one headline price chosen randomly from the firms in that market. In addition, a consumer can make  $K \leq N$  extra observations, which can be any combination of headline prices and additional prices plus conditions. Specifically, for each observation the consumer chooses a firm whose headline price she has observed, and learns either that firm’s additional price and condition or the competitor’s headline price. All of our other assumptions remain unchanged.<sup>25</sup>

As with other extensions and variants, we do not fully characterize the set of equilibria—which

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<sup>25</sup> One modeling choice in our multi-market model is worth noting. Although we assume that the consumer can use her attention for any combination of browsing and studying, we still do not allow her to use her attention for other activities. Of course, in reality an individual can use the energy she saves by (say) not studying a product not only for browsing or studying something else, but also for working, entertainment, rest, etc. Nevertheless, if a consumer with limited attention studies a lot, then her marginal cost of browsing must in general increase, so she will tend to browse less. Our model captures such a broad crowd-out effect in a simple way.

in fact appears intractable for the current model—but look for the types of equilibria we have found previously. In particular, we ask whether an equilibrium along the lines of Proposition 4 or an equilibrium with competitive pricing exist.

**Proposition 7.** *There is a symmetric equilibrium with the following properties. Firms charge the maximum additional price  $\bar{a}$ . Low-income consumers study in  $K$  randomly chosen markets, avoiding  $\bar{a}$  in these markets and incurring  $\bar{a}$  in the other markets. High-income consumers incur  $\bar{a}$  in all markets, and browse in the  $K$  markets in which their initial headline price is highest. Firms choose headline prices according to a continuous distribution with support  $[f_{min}, f_{max}]$ , and at each price earn expected profits equal to  $\alpha (f_{max} + (1 - K/N)\bar{a} - c) / 2$ . Furthermore,  $f_{max}$ , and the expected price that consumers pay, are strictly increasing in  $\alpha$ .*

Proposition 7 says that our multi-market model in a large part reproduces the results of the single-market model multiple times. The main difference is that high-income consumers now optimize their browsing across markets, checking the competitor in the  $K$  markets in which their initial offer is the worst. Even so, the multi-market model still features the central prediction that the average price consumers pay is increasing in the share of low-income consumers. The reason is also the same: low-income consumers use all of their limited attention for studying, so they do not comparison shop, resulting in less competition between firms.

Having confirmed that the features of our baseline equilibrium survive in our multi-market model, we turn to reassessing the effects of regulation. Because it remains tractable with multiple markets, we consider the kind of plain-vanilla regulation we have analyzed in Section 5.1. Suppose that in  $J$  of the  $N$  markets, the social planner imposes a known default of  $\gamma_d = 0$ ; and if a firm wants to choose another  $\gamma_i$ , it must ask consumers to agree, which consumers can refuse without needing to study the offer. Such a regulation modifies the above equilibrium in the following way:

**Proposition 8.** *If  $J \leq N - K$ , then there is an equilibrium in which the distribution of firms' prices is the same as in Proposition 7, and there is no equilibrium in which all firms charge the additional price  $\bar{a}$  along with the zero-profit headline price. If  $J > N - K$ , then there is an equilibrium in which all firms charge the additional price  $\bar{a}$  along with the zero-profit headline price, and there is no equilibrium in which the distribution of firms' prices is the same as in Proposition 7. In both*



*types of equilibrium, high-value consumers incur  $\bar{a}$  in all markets, while low-value consumers incur  $\bar{a}$  in  $\max\{0, N - K - J\}$  markets.*

As in our basic model, if the social planner regulates all markets ( $J = N$ ), then all markets become perfectly competitive. Not having to study in any of the markets, all consumers can browse, generating Bertrand competition between firms.

But the effect of limited regulation ( $J \leq N - K$ ), though positive, is more modest. As an example, suppose that  $K < N$ , and the planner regulates a single market. The regulation accomplishes what might be its main goal: it allows low-income consumers to avoid the additional price in the regulated market. But it does not change the distribution of headline prices in any of the markets. Intuitively, low-value consumers use the attention they save by not having to study the regulated market to study another market, rather than to browse. Nevertheless, even this case illustrates an economically important point: that the benefits of regulating a market do not necessarily accrue in the same market. In our model, in each other market the proportion of low-value consumers avoiding the additional price increases from  $K/N$  to  $K/(N - 1)$ . Hence, the lack of sufficient welfare gain in the regulated market does not mean that the regulation is not welfare-increasing overall.

Furthermore, Proposition 8 implies that the transition from a modest regulatory effect to a major one can be highly non-linear. While regulating more and more markets initially does not change the distribution of headline prices, once a sufficiently large number of markets is regulated ( $J > N - K$ ), *all* markets suddenly become perfectly competitive. At this stage, low-value consumers are liberated from using all their attention for studying, so they can engage in some browsing. A firm that charges a high headline price therefore loses all consumers, guaranteeing a competitive outcome.

The main message that emerges from the above considerations is that for regulation to have the drastic pro-competitive effect identified in our paper, it must be sufficiently broad in scope. This conclusion strengthens the argument that our results call for a broad legal principle rather than a market-by-market fine-tuned regulation of secondary features. The other side of the same coin, however, is that while the regulation must be sufficiently broad, it does not necessarily have to extend to all markets. This observation is fortunate because there are likely to be markets in

which our competition-inducing regulation is infeasible or (as we have discussed above) undesirable based on classical efficiency reasons, and these markets can therefore be left outside the scope of regulation. At the same time, if the social planner does not know consumers' attentional limitations ( $K$ ), then it might be difficult to know how much can be left outside the scope of regulation.

## 7 Related Literature

In this section, we summarize related research not discussed elsewhere in the paper. While we point out other differences below, ours is the first paper to study the implications of the tradeoff between browsing and studying for firm pricing and regulation, and this novel tradeoff yields several insights that have not been derived from previous work. Most importantly, we provide a formal argument as to why interventions such as safety regulations, strict liability, or the fair contracts principle increase competition, why secondary features rather than total prices or values should be regulated, and why the breadth of regulation is an important determinant of its effectiveness.

### 7.1 Hidden Prices

A central premise of our model is that there are price or contract components consumers may not fully observe or understand when making purchase decisions.<sup>26</sup> Researchers have documented the existence of such hidden prices in a variety of markets (e.g., Choi et al., 2010, Anagol and Kim, 2012, Duarte and Hastings, 2012, Agarwal et al., 2015, 2016a, Grubb and Osborne, 2015). This evidence is variously interpreted in terms of the limited salience of some price components or the naivete or limited attention of some consumers. Our results require limited consumer attention, but they are relevant both when consumers are naive and when consumers are sophisticated.

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<sup>26</sup> This premise is shared by a growing theoretical literature on consumer naivete in markets, which asks questions orthogonal to ours. See, for instance, Gabaix and Laibson (2006), Eliaz and Spiegler (2006), Spiegler (2006b), Grubb (2009), and Heidhues and Köszegi (2010) for a few contributions, and Grubb (2015a) and Heidhues and Köszegi (2018) for reviews.

## 7.2 Bounded Rationality

Our paper is related to the literature on rational inattention in that consumers optimally choose what they pay attention to. That people make such strategic attentional decisions is documented by Bartoš et al. (2016), and implications are explored, among many others, in Sims (2003, 2010), Mackowiak and Wiederholt (2009), and Matějka and McKay (2015). In much of the literature, the uncertainty that consumers seek to understand is exogenously given, whereas in ours it results from optimizing decisions by firms.

In our model, regulation of secondary features enhances competition by encouraging comparative search by consumers. In a related vein, the literature on choice complexity (e.g., Carlin, 2009, Piccione and Spiegler, 2012, Chioveanu and Zhou, 2013, Spiegler, 2016), which posits that firms use price formats to influence the ability of consumers to understand or compare prices, emphasizes the importance of comparability for competition. Being about the framing of prices, the comparability literature connects more naturally to disclosure regulations than to product regulations,<sup>27</sup> although Grubb (2015c) emphasizes that regulating prices to be scalars can also enhance comparability. While our mechanism suggests similar interventions in some circumstances, it does not rely on reducing the complexity of products—but on obviating the need to examine complex products carefully. For instance, car safety regulations might well make the physical properties of cars more difficult to understand or compare, but these properties now become details that consumers do not need to worry about.

A few papers study the interaction between boundedly rational consumers and profit-maximizing firms. Unlike in our model, in most papers consumer search/attention is exogenously specified (e.g., Spiegler, 2006a, Armstrong and Chen, 2009, Bachi and Spiegler, 2018, Grubb, 2015b), but there are exceptions. Ravid (2017) modifies a standard bargaining model by assuming that the buyer is rationally inattentive to the product’s quality and the seller’s offers. He finds that this increases the buyer’s surplus. Roesler (2015) studies a monopolist selling to a consumer who chooses how to learn about product value taking into account the impact on the subsequent pricing decision of the

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<sup>27</sup> Indeed, Piccione and Spiegler’s (2012) leading regulatory example is standardization of information, such as that required on nutritional labels.

firm. She establishes that the consumer prefers a coarse perception of her own valuation. Gamp and Krämer (2017) consider a search model in which firms choose quality, and naive consumers erroneously believe that all firms offer high quality. They show that as search frictions disappear, low-quality products come to dominate the market and naive consumers' purchases. In a framework closely related to our multi-market model, De Clippel et al. (2014) study a different aspect of competition with strategically inattentive consumers. In the model, consumers observe the price of the market leader in each of multiple markets, and can also inspect competitors' prices in a given number of markets of their choice. By lowering its price, a market leader increases the chance that the consumer ignores competitors and buys from it, so that leaders effectively compete for consumer inattention. An increase in consumers' capacity to inspect markets can induce leaders to focus on exploiting the most inattentive consumers, lowering competition and increasing prices.

### 7.3 Search

Even beyond research already discussed in Section 5.2, our paper is related to the literature on consumer search. At a formal level, our model modifies three assumptions that the vast majority of this literature makes: (i) once a consumer decides to search a product, she comes to understand the product perfectly; (ii) the cost of searching products is linear; and (iii) the way in which consumers can search is exogenously fixed.<sup>28</sup> A few researchers have modified these assumptions, but always one at a time. Replacing (i), Gamp (2015) considers consumers who can purchase a product without knowing its price. Replacing (ii), Carlin and Ederer (2012) and Ellison and Wolitzky (2012) assume convex search costs. And replacing (iii), Haan et al. (2015) and Armstrong (2016) have started to investigate directed search.

Most closely related to our paper is Ellison and Wolitzky (2012), who study a model of oligopolistic competition with convex search costs in which a firm can increase the time needed to learn its price (i.e., “obfuscate”). Since search costs are convex, obfuscation also increases the cost of learning another product's price and therefore reduces competition and benefits the firm. Although Ellison

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<sup>28</sup> For models of non-sequential search, see for instance Salop and Stiglitz (1977), Varian (1980), and Burdett and Judd (1983), and for models of sequential search, see for instance Lippman and McCall (1976), Reinganum (1979), Carlson and McAfee (1984), and Stahl (1989).

and Wolitzky do not discuss policy, the logic of their model suggests that regulations restricting the firm’s attempt to increase search costs can be pro-competitive. More generally, perhaps the most basic implication of the search literature is that reducing search costs increases competition. Once again, in our model regulation works not by making it easier to understand a product, but by making it safe to look at a product only superficially. This explains why safety regulations, strict liability, or the unfair contracts principle—which do not necessarily reduce the difficulty of searching a product—are pro-competitive.

## 7.4 Regulation

The case for regulation we make has some parallels with the idea of “managed competition” researchers have proposed in the context of health-insurance markets in the US (e.g., Enthoven, 1993). Managed competition is defined as a group-insurance purchasing strategy that “structures and adjusts the market to overcome attempts by insurers to avoid price competition.” Though we are unaware of a formal treatment of this idea and a precise mechanism is not spelled out, one piece of the proposed strategy is the standardization of plans to make consumers more price sensitive, in part by ensuring that consumers are not worried about hidden gaps in coverage.

Some previous papers have discussed indirect ways in which regulation can increase efficiency that are completely different from ours. Most importantly, Shleifer (2011) and Schwartzstein and Shleifer (2013) identify an efficiency-increasing role for regulation when courts are imperfect. Shleifer (2011) singles out especially contract regulations, emphasizing that from a classical perspective contracts are a substitute for regulation (e.g., for dealing with externalities), and hence should not themselves be the objects of regulation. To explain why contracts are nevertheless regulated, Shleifer argues that litigation is “expensive, unpredictable, or biased,” rendering regulation the more efficient alternative. Schwartzstein and Shleifer (2013) construct a model in which firms decide whether to take safety precautions, and courts make errors in determining whether precautions were ex-ante necessary. This makes litigation following accidents unpredictable, creating a risk that discourages firms from entry. Schwartzstein and Shleifer show that imposing a regulatory standard, and partially or fully exempting firms that comply with the standard from litigation,

can induce more entry while still encouraging safety precautions. If the social return from entry is higher than the private return, therefore, regulation increases efficiency.

The main existing rationales for strict liability are based on consumers' misestimation of product danger (e.g., Spence, 1977, Polinsky and Rogerson, 1983) or consumers' and producers' incentives to invest in safety (e.g. Shavell, 1980). These papers either abstract from the market structure or take the level of competition in the market as fixed. In contrast, our mechanism is centered on the competition-inducing effect of strict liability.

Because regulation of a product feature can be thought of as partial standardization, our policy analysis is superficially related to the literature on technological standard setting in the presence of network externalities (e.g., Besen and Farrell, 1994). Our model applies absent network effects and the standards' main purpose is to facilitate browsing, an aspect the former literature ignores. Relatedly, Ronnen (1991) shows that minimum quality regulation can increase price competition in oligopolistic markets by making products closer substitutes. In our setting, regulation can induce competition without directly changing substitutability. Furthermore, in Ronnen a non-binding regulation never affects equilibrium outcomes, there is no parallel to the insight that additional and not total prices should be regulated, and regulation does not work through influencing consumers' search behavior.

At a very broad level, our main policy point is related to the notion that good institutions are important for economic growth (e.g., Acemoglu and Robinson, 2010). One commonly agreed role of institutions, for instance, is to protect individuals from exploitation in business deals, so that smooth exchange can take place. Our paper identifies a new mechanism through which institutions help markets.

## 8 Conclusion

While we have focused on prices in this paper, it would seem worthwhile to analyze the effects of our competition-enhancing regulations on other market outcomes. As a notable example, one wonders how such a regulation affects firms' incentive to innovate. In as much as the regulation induces firms to improve products along the core dimensions consumers care about—such as thinking about the

functionality and style of baby furniture rather than attempting to skimp on safety—the indirect effect on innovations could be substantially beneficial. But in as much as the regulation induces firms to think about how to get around it—e.g., by inventing new fees for a mortgage—the indirect effect on innovations can also be detrimental.

There is also an obvious implication of limited attention that we have invoked when discussing our findings, but that we have not formally incorporated into our model: that consumers need to devote attention to understanding policies, and this crowds out paying attention to other things. In future work, we plan to develop and analyze a framework incorporating this consideration.

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# Web Appendix

## A Robustness

In this section, we argue that our qualitative results carry over to all extensions of our baseline model that we have discussed in Section 3.2. We order our discussion along the main Propositions for the model of Section 3.

*Proposition 4.* First, the extreme form of convex attention costs we have assumed in Section 3—that observing two prices is free, but observing anything else is impossible—is not crucial for our results. We now relax this assumption and assume consumers can at a cost learn further prices. Denote the cost of searching price number  $n$  by  $s_n$ . Search costs are weakly increasing such that  $s_{n+1} \geq s_n$  for all  $n$ . Consider first the case in which—as in Section 3—searching the first two prices is for free ( $s_1 = s_2 = 0$ ). Searching the third price requires effort  $s_3 > 0$ .

The following proposition summarizes how results from Proposition 4 are robust to this specification.

**Proposition 9.** *There exists an equilibrium with the following properties. All firms charge an additional price of  $\bar{a}$ . Low-value consumers study and avoid paying the additional price, while high-value consumers browse and incur the additional price. For any  $s_3 > 0$  all consumers search two price components. Firms choose headline prices according to a distribution with support  $[f_{min}, f_{max}]$ , and at each price earn expected profits equal to  $\alpha(f_{max} - c)/I$ . Furthermore, there exists an  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  for  $\alpha \geq \alpha^*$ . If  $s_3 \geq \bar{a}$ ,  $f_{max} = E[f] + \bar{a} < v_L$  for  $\alpha < \alpha^*$ . If  $s_3 < \bar{a}$ ,  $f_{max} = E[f] + s_3 < v_L$  for  $\alpha < \alpha^*$ . In both cases, the expected price that consumers pay is increasing in  $\alpha$ .*

The main logic from Proposition 4 applies in this context. Firms compete for inattention of low-value consumers. Firms set  $f_{max}$  just low enough to prevent low-value consumers from searching a third price. This  $f_{max}$  will be sufficiently low to also discourage high-value consumers from browsing more than two products.

Intuitively, consumers searching a third price introduces a new inattention constraint that is irrelevant in the model of Section 3. Studying low-value consumers might be tempted to browse and study a second offer at a cost  $s_3$ . If  $s_3 \geq \bar{a}$ , browsing and studying a second offer is very costly, making this deviation inferior to only browsing a second offer. In this case the search cost  $s_3$  are irrelevant for equilibrium attention and the equilibrium of Proposition 4 is unaffected. For  $\alpha < \alpha^*$ ,  $f_{max}$  is determined by  $f_{max} = E[f] + \bar{a}$  and the price cap  $\bar{a}$  drives competition for inattention.

If  $s_3 < \bar{a}$  the novel inattention constraint is binding. Browsing and studying a second offer is the most beneficial deviation for low-value consumers. For  $\alpha < \alpha^*$ ,  $f_{max}$  is determined by  $f_{max} = E[f] + s_3$ . Now the search cost  $s_3$  drives competition for inattention and no longer the price cap  $\bar{a}$ . But as in the previous case, firms reduce  $f_{max}$  to prevent low-value consumers from studying a second offer. Even though the inattention constraint is a different one, firms again compete for consumer inattention and the comparative statics w.r.t.  $\alpha$  are qualitatively unaffected.

Which inattention constraint is binding has important implications for price regulation. Consider again  $\alpha < \alpha^*$ . If  $s_3 < \bar{a}$  and  $f_{max} = E[f] + s_3$ , the search cost  $s_3$  induce competition for

inattention. Thus, a small reduction of  $\bar{a}$  that preserves  $s_3 < \bar{a}$  only reduces the additional price that high-value consumers pay, which reduces competitive pressure. Just as a decrease in  $\bar{a}_H$  in Proposition 10, this leads to an *increase* in the average price consumers pay. In contrast, a large enough reduction of  $\bar{a}$  induces  $s_3 > \bar{a}$  where  $f_{max} = E[f] + \bar{a}$ . Now the price cap  $\bar{a}$  drives competition for inattention, and a reduction in  $\bar{a}$  *reduces* the average price consumers pay.

What would happen to the results of Proposition 4 if  $s_2 > 0$ ? As long as  $s_2 \leq \bar{a}$ , low-value consumers still study their initial offer. But high-value consumers would no longer browse when they observe initial prices close to  $f_{min}$ . As a response, firms increase  $f_{min}$ ; firms play pure strategies in equilibrium and high-value consumers neither browse nor study. The problem is that high-value consumers benefit from browsing only because of some price variation in headline prices. Realistic extensions—commonly assumed in the search literature—that induce variation in benefits for high-value consumers, however, induces them to pay (low enough)  $s_2 > 0$  as well. For example, if by browsing high-value consumers learn their match value they have an incentive to incur search cost. Alternatively, if as in Stahl (1989) or Janssen et al. (2005) there are some consumers with zero search cost or intrinsic benefits from browsing (so-called shoppers), then headline prices must vary in equilibrium. This price variation, in turn, induces high-value consumers to pay (low enough)  $s_2$  and browse as well. These extensions also make the results in Proposition 4 robust to  $s_1 > 0$ .

To simplify the discussion, for the remainder of this Appendix, we again suppose that consumers can only observe two prices.

Second, we note that it is easy to check that an equilibrium with essentially the same properties exists if browsing and studying occur in different markets.

Third, suppose that high-value but not low-value consumers avoid all or part of the additional price without studying. We capture this by positing that the maximum additional price a firm can charge is  $\bar{a}_H \geq 0$  for high-value consumers and  $\bar{a}_L > 0$  for low-value consumers.<sup>29</sup> We show that the equilibrium characterized in Proposition 4 survives qualitatively unchanged, and in fact features interesting comparative statics:

**Proposition 10.** *The average total price consumers pay is decreasing in  $\bar{a}_H$ , and increasing in  $\bar{a}_L$ .*

It has long been recognized in models of loss leaders (e.g., Lal and Matutes, 1994), switching costs (e.g., Farrell and Klemperer, 2007), and naive consumers (e.g., DellaVigna and Malmendier, 2004) that the profits firms make on consumers ex post are competed away in an effort to attract consumers ex ante. In our model, the profits firms make on high-value consumers ex post are *more than* competed away ex ante, so that the average price consumers pay is *decreasing* in these ex-post profits. Intuitively, the ex-ante competition for profitable high-value consumers increases the threat of low-value consumers browsing, inducing firms to lower prices further. In contrast, the average total price is increasing in the additional price low-value consumers would pay—even though low-value consumers do not pay it. A higher additional price lowers low-value consumers’ incentive to browse, which in turn lowers firms’ incentive to keep prices depressed.

Unlike in our baseline model, in markets where high-value consumers face a lower additional price than low-value consumers, it is no longer generally true that high-value consumers pay higher

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<sup>29</sup> We continue to assume that high-value consumers’ cost of satisfying almost any condition is greater than  $\bar{a}_H$ , and to ensure that the market is covered that  $v_L + \bar{a}_H \leq v_H$ .

average prices. This happens not because low-value consumers pay the high additional price, but because they are spending their effort trying to avoid the additional price. Since high-value consumers browse and then pay a relatively small additional price, they may obtain the product at a lower price. Of course, in this case the prediction that the average price consumers pay increases in  $\alpha$  is only strengthened.

Our results also survive if low-value consumers are naive: they believe that by studying, they can avoid the additional price, whereas in reality they will incur a given proportion of it. This leaves the equilibrium prices completely unchanged:

**Corollary 1.** *The properties of equilibrium prices identified in Proposition 4 are unaffected by the proportion of the additional price naive consumers incur after studying.*

While the ex-post profits firms make on high-value consumers are more than competed away, the ex-post profits they make from unexpected payments by naive low-value consumers are not competed away at all. Since naive low-value consumers do not anticipate paying the additional price, the fact that they pay does not affect their perceived-optimal search behavior. And since low-value consumers study, they cannot be attracted by a cut in the headline price. This means that the additional price they unexpectedly pay does not induce any competition in the headline price. Once again, in this case low-value consumers may end up paying higher average prices than high-value consumers.

It is important to note that Corollary 1 relies on naive consumers realizing that there is an additional price to worry about, and believing that they can avoid it. Suppose, in contrast, that—as in Gabaix and Laibson (2006), Heidhues et al. (2017), and Johnen (2017), for instance—naive consumers are completely oblivious to the additional price, equating the headline price with the total price of the product. Then, they browse just like high-value consumers, generating perfect competition between firms. In a sense, therefore, partial naivete can lead to higher prices and more exploitation of naive consumers than complete naivete.

*Proposition 5.* As in this equilibrium there is no benefit to further search, the equilibrium survives unchanged if consumers can observe further prices at a positive cost. The implications of naivete by low-value consumers depend on how much unexpected charges firms can impose on these consumers, and how this is related to  $a_i$ . If a firm can generate large profits from low-value consumers by increasing  $a_i$ , then the equilibrium must involve doing so and thereby pricing high-value consumers out of the market. Otherwise, the equilibrium survives. If consumers face different additional prices, the equilibrium survives so long as firms can charge all consumers a sufficiently high additional price ( $\bar{a}_L > 0, \bar{a}_H > v_H - v_L$ ).<sup>30</sup> Finally, we have discussed the possibility that browsing and studying occur in different markets in the text.

*Proposition 6.* Again, there is no benefit to further search, so the equilibrium survives if consumers can observe further prices at a cost. Since there is no benefit to studying, competitive (zero-profit) equilibria in which all consumers browse also exist when low-value consumers are naive or high-value consumers avoid (part of) the additional price for free. The same logic applies when studying and browsing occur in different markets. Finally, when studying is aimed directly at

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<sup>30</sup> If high-value consumers automatically avoid any additional price even in a deregulated market, then they can safely browse, so a cap on low-value consumers' additional price leaves the equilibrium unchanged.

avoiding—rather than learning how to avoid—the additional price, then the plain-vanilla regulation works so long as it makes avoiding the additional price costless.

## B Entry

We analyze a model of how entry interacts with the attention issues at the heart of our paper. We modify the model in Section 3.1 by assuming that there are three firms, two incumbents (firms 1 and 2) and an entrant (firm 3), and each consumer initially observes the headline price of a randomly chosen incumbent firm. Consumers can either study the additional price and conditions of their own firm, or look at the headline price of one randomly chosen other firm. Both of these randomizations are with equal probability. All our other assumptions are unchanged.

As we have shown in Proposition 4, without the entrant the incumbents’ profits are increasing in the share of low-value consumers,  $\alpha$ . One might naturally conjecture that the entrant’s expected profit—and hence its willingness to enter—is therefore also increasing in  $\alpha$ . Instead:

**Proposition 11.** *In equilibrium, all firms charge an additional price of  $\bar{a}$ . Low-value consumers study and avoid paying the additional price, while high-value consumers browse and incur the additional price. Firms 1 and 2 choose their headline prices according to the same unique continuous distribution with support  $[f_{min}, f_{max}]$ , while firm 3 chooses its headline price according to a unique continuous distribution with support  $[f_{min}, \bar{f}_3]$ , where  $f_{min} < \bar{f}_3 < f_{max}$ . Firms 1 and 2 earn expected profits of  $\frac{\alpha}{2}(f_{max} - c)$ , and firm 3 earns an expected profit of  $\frac{(1-\alpha)\alpha}{(3-\alpha)}(f_{max} + \bar{a} - c)$ . Furthermore, there exists an  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  for  $\alpha \geq \alpha^*$  and  $f_{max} < v_L$  for  $\alpha < \alpha^*$ . The expected price that consumers pay is increasing in  $\alpha$ .*

Proposition 11 says that entry preserves the structure of equilibrium consumer behavior we have found in the basic version of our model: high-value consumers browse, but low-value consumers find it more advantageous to study. As a result, the entrant’s profit is increasing in  $\alpha$  for low  $\alpha$ , but decreasing in  $\alpha$  for high  $\alpha$ . When  $\alpha$  is small, most consumers browse, and the resulting Bertrand-type competition leaves the entrant with low profits. When  $\alpha$  is high, most consumers study and hence cannot be attracted away from the incumbents, again leaving the entrant with low profits. For intermediate values of  $\alpha$ , however, incumbents keep prices high to take advantage of studying low-value consumers, so the entrant can ensure non-trivial profits by competing for browsing high-value consumers.

Once a neighborhood has a sufficiently large share of low-value consumers, therefore, economic incentives create a “desert” in which new firms have little incentive to enter, even though incumbents are making large profits. Exactly the same force that allows incumbents to make large profits—lack of comparative search by consumers—makes it difficult for an entrant to carve out significant market share.

Worse, Proposition 11 implies not only that for high  $\alpha$  entry is unlikely to occur, but also that the average price consumers pay *increases* if entry does occur. Intuitively, because the entrant makes it more difficult to attract browsing consumers, incumbents focus their business model more on studying consumers, raising average prices. And because high-value consumers at least benefit



from the presence of the entrant, the increase in prices is borne entirely by low-value consumers.<sup>31,32</sup>

## C Regulating Headline Prices

The central message of our paper is that regulating secondary product features, such as add-on prices, has pro-competitive effects when consumers have limited attention and therefore can only do a limited search of available options. In contrast, Fershtman and Fishman (1994) and Armstrong et al. (2009) show that putting a cap on a product’s (single) price can lead to higher average prices in search markets. Given the drastically different conclusions from related setups, it is natural to ask how the results are connected. In this section, we show that capping the *headline* price in our model can lead to a similar increase in prices—and for the same reason—as in Fershtman and Fishman (1994) and Armstrong et al. (2009). In combination with our main results, this reinforces our argument that it is regulation of secondary features, not interference with a market’s core price mechanism, that has pro-competitive effects.

To make our point, we replicate the analysis of Armstrong et al. (2009) within our framework of Section 3. Specifically, we assume that before seeing any prices, high-value consumers decide whether to become “more informed” or “less informed.” A more informed consumer is exactly like a consumer in our basic model, while a less informed consumer sees one randomly chosen headline price and can observe nothing else. The cost of becoming more informed is  $s \geq 0$ . For simplicity, we impose that all low-value consumers become more informed.<sup>33</sup> All other features of our model are unchanged.

We illustrate that in the above framework, a cap on headline prices can hurt consumers: exactly because it shields consumers from high headline prices, it can reduce the incentive to become more informed and thereby lower the intensity of competition. When constructing such an example, we follow the search literature (see e.g. Armstrong et al. (2009)) and focus on stable equilibria—equilibria in which the value of becoming more informed is strictly decreasing in the share of informed consumers.

**Proposition 12.** *There exist stable equilibria and parameters such that introducing a cap on the headline price increases firms’ equilibrium profits and makes consumers worse off.*

<sup>31</sup> To understand these results in more detail, notice that for high  $\alpha$ —where  $f_{max} = v_L$ —the incumbents’ profits are unaffected by entry. When setting  $f_{max} = v_L$ , an incumbent earns profits from its low-value consumers only, and entry does not affect these profits because low-value consumers do not browse the entrant’s offer. Given that the incumbents earn the same profits and the entrant earns higher profits than without entry, consumers must pay more on average. Furthermore, note that to keep an incumbent indifferent between different prices, the probability that the firm loses a high-value consumer must at any price be the same with and without entry. This implies that at any price, a high-value consumer has the same probability of finding a lower price—that is, the distribution of prices she pays is the same.

<sup>32</sup> The point that entry might increase prices in a Varian-type pricing model has previously been made by Janssen and Moraga-González (2004). In the equilibrium of their model that resembles Varian-type pricing, entry increases the average price that firms charge, not the average price that consumers pay (the latter remains unchanged). In other equilibria, the number of firms might affect average consumer prices via the search intensity of consumers. In our model, search intensity is constant.

<sup>33</sup>In the equilibrium we solve for, low-value consumers would want to become more informed for any  $s \leq \bar{a}$ .

## D Competitiveness versus Efficiency

Our results on policy mostly identify the effect of regulation on the *competitiveness* of the market, even if in some situations regulation also increases efficiency by bringing high-value consumers into the market. In this section, we further discuss the effect of regulation on efficiency in natural variants of our model. We argue that the regulation-induced competition often enhances efficiency; but we show that when finding the right product requires studying, there is a tradeoff between competition and efficiency.

Consider first the version of our basic model in which consumers cannot avoid the additional price. While we have assumed that consumers are homogeneous, of course it is plausible to assume that consumers are heterogeneous. The main message of Propositions 1 and 2 still holds: without regulation, it is an equilibrium for firms to act as monopolists, and with regulation, it is an equilibrium for them to act perfectly competitively. In this situation, an increase in competition has the classical efficiency-enhancing effect of serving all consumers who value the product above marginal cost.

A somewhat more subtle efficiency-enhancing effect of regulation occurs if the base products of the firms are horizontally differentiated, but the services associated with the additional price are not. This would be the case, for instance, if the additional price is simply an extra charge that consumers pay only because they find it too costly to avoid. Then, in as much as regulation leads a consumer to browse rather than study, it facilitates finding the product that matches her preferences, increasing efficiency.

The opposite is the case, however, if consumers are unsure about how much they value different versions of a product, and need to study to learn their valuations. We show this possibility through a simple model. There are  $I$  identical firms that each sell a basic product and a premium product. The premium product could be a higher-quality version of the basic product, or the basic product embellished with an add-on. Firm  $i$  charges  $f_i$  and  $f_i + a_i$  for the basic and premium products, respectively. A consumer values the basic product at  $v$ , but her valuation for the premium product is uncertain: it is either  $v$  or  $v + \bar{a}$ , each with positive probability. Producing the basic product costs zero, and producing the premium product costs  $c$ . We assume  $\bar{a} > c$ , so that the premium product is efficient for consumers who value it. Each consumer is initially assigned to one firm, with each firm getting a share  $1/I$  of consumers. A consumer assigned to firm  $i$  sees both  $f_i$  and  $a_i$ . If she then studies, she finds out whether she prefers firm  $i$ 's basic or premium product. If she browses, she learns another firm's prices (drawn with equal probability from the rivals), but not which product she prefers. Then:

**Proposition 13.** *Marginal-cost pricing is not an equilibrium. There exists an equilibrium in which  $f_i = v$  and  $a_i = \bar{a}$  for all  $i \in I$ , and all consumers study.*

The competitive outcome is not an equilibrium. For firms to compete, consumers have to browse—but this is not stable because facing marginal-cost pricing, consumers have a strict incentive to learn their match values. Instead, there is an equilibrium in which consumers learn their match values and therefore do not browse, so that firms can charge monopoly prices. While not competitive, this outcome is efficient: all consumers buy the product that is best for them.

Now consider a standardization policy that allows firms to offer only the basic product. Then, there is no point in studying, leading consumers to browse and generating Bertrand competition. The policy therefore reduces choices for consumers and reduces efficiency, but also lowers prices.

## E Proofs

**Proof of Proposition 1.** We first show that in equilibrium almost all consumers who buy study. Suppose otherwise, i.e., suppose the probability that a consumer browses and then buys is positive. Then there is a firm  $i$  and a headline price  $f_i$  such that firm  $i$  attracts a positive mass of browsing consumers conditional on charging  $f_i$ . Firm  $i$  can profitably deviate by charging the same  $f_i$  while increasing the corresponding  $a_i$  arbitrarily. This enables firm  $i$  to earn unbounded profits, contradicting equilibrium. We conclude that almost no browsing consumer buys with positive probability.

We now know that consumers purchase with positive probability only if they study with positive probability. Any consumer who studies accepts any offer for which  $f_i + a_i < v$ . Hence, if a positive mass of consumers studies in equilibrium, then firms must charge  $f_i + a_i = v$ . Finally, an equilibrium in which all firms charge  $f_i + a_i = v$ , all consumers (besides those who browse by assumption) study, and all consumers buy clearly exists.  $\square$

**Proof of Proposition 2.** Our proof has five steps. In Step (i), we show that consumers buy with probability one. We prove in Step (ii) that total prices are below  $v$  with probability one. Step (iii) establishes that all consumers browse at all headline prices for which the total expected price is not below that of all rivals with probability one. Step (iv) uses this fact and standard Bertrand-type reasoning, to establish that all firms must set the same total expected price. Step (v) shows that there is a profitable deviation whenever this total expected price does not equal marginal cost.

*Step (i): all consumers buy with probability one.* Sequential rationality implies that upon observing a headline price  $f_i < v - \bar{a}$ , a consumer must buy with probability one. Suppose some consumers do not buy with positive probability in equilibrium. Then there must exist a firm  $i$  that with positive probability charges a headline price  $f_i \geq v - \bar{a}$ , and a positive mass of consumers that are initially assigned to firm  $i$  and do not buy with positive probability conditional upon observing such a headline price. We argue that conditional on such an  $f_i$ , firm  $i$  cannot charge a total price strictly below  $v$  and sell to a positive mass of consumers. If it did so, firm  $i$  could increase  $a_i$  by a small amount and still charge a total price below  $v$ ; after this change consumers who study still buy and as such a deviation is unobservable to browsing consumers, it also does not change their buying behavior. Hence, firm  $i$  must charge a total price  $f_i + a_i \geq v$  with probability one if it sells to some consumers. Furthermore, firm  $i$  cannot be selling with probability zero. For it could then deviate and set a pair of prices  $f_i \in (c - \bar{a}, v - \bar{a})$  and  $a_i = \bar{a}$ , for which all consumers strictly prefer buying. And because in the candidate equilibrium some consumers buy with probability less than one after observing  $f_i$ , this attracts additional consumers with positive probability, a contradiction. Next, we establish that for such an  $f_i$ ,  $f_i + a_i = v$  with probability one. For otherwise, since it charges total prices below  $v$  with probability zero, browsing consumers strictly prefer not buying from firm

$i$  and studying consumers do not buy from firm  $i$  whenever it charges a total price greater than  $v$ , contradicting the fact that firm  $i$  must sell with positive probability for all price pairs. Almost all studying consumers must buy with probability one, for otherwise the firm could lower  $a_i$  by an arbitrarily small amount, thereby inducing all studying consumers to buy without changing the purchase behavior of browsing consumers, and this is a profitable deviation. If browsing consumers do not buy with positive probability, then the firm can deviate and set prices  $f_i = v - \bar{a} - \eta$  and  $a_i = \bar{a}$ , which increases the demand from the browsing consumers for any positive  $\eta > 0$ , and hence it is profitable if all consumers browse conditional on seeing  $f_i$ . Furthermore, if some consumers study, then since they earn zero surplus from firm  $i$ , they must in equilibrium also earn zero surplus from browsing. Hence, the deviation, which gives consumers a small positive surplus, attracts all consumers with probability one and thus is profitable. We conclude that all consumers purchase with probability one in equilibrium.

*Step (ii): all firms set total prices  $f_i + a_i < v$  with probability one.* Suppose otherwise, that is some firm  $i$  sets a total price of  $f_i + a_i \geq v$  with positive probability in equilibrium. Then all its rivals must earn positive profits in equilibrium, for they would earn positive profits when setting a pair of prices  $f_j \in (c - \bar{a}, v - \bar{a})$  and  $a_j = \bar{a}$ . Let  $\pi$  be the lowest expected equilibrium profits from any rival of  $i$ . Then each rival must charge a total price weakly greater than  $c + \pi$  with positive probability, and hence firm  $i$  can ensure positive profits by charging a pair of prices  $f_i = c + \pi/2 - \bar{a}$  and  $a_i = \bar{a}$ . Hence, firm  $i$  must earn positive expected profits when charging an optimal pair of prices  $f'_i, a'_i$  for which  $f'_i + a'_i \geq v$ . Hence, conditional on observing  $f'_i$ , consumer either study and buy or browse. In either case, it is suboptimal to charge an additional price of  $a_i < v - f'_i$ , for otherwise firm  $i$  could raise  $a_i$  slightly without reducing demand. In other words,  $\mathbb{E}(f'_i + a_i | f'_i) \geq v$  and if  $\mathbb{E}(f'_i + a_i | f'_i) > v$  browsing consumers do not buy and studying consumer do not buy when  $f'_i + a_i > v$ , so that firm  $i$  for prices  $(f'_i, a_i)$  has zero sales, and hence zero profits—contradicting the fact that for optimal prices  $i$  earns positive equilibrium profits. Thus,  $\mathbb{E}(f'_i + a_i | f'_i) = v$  and hence for firm  $i$  to earn positive profits some rival must set headline prices for which  $\mathbb{E}(f_j + a_j | f_j) \geq v$ . But then firm  $i$  can profitably attract the browsing consumers of firm  $j$  by deviating and setting prices  $(\hat{f}_i, \hat{a}_i)$  such that  $\hat{a}_i = \bar{a}$  and  $\hat{f}_i = v - \bar{a} - \eta$  for a sufficiently small  $\eta > 0$ , a contradiction. We conclude that all firms set total prices  $f_i + a_i < v$  with probability one.

For the equilibrium price distribution, let  $\underline{\mathbb{E}}_i = \inf\{\mathbb{E}(f_i + a_i | f_i)\}$ , and let  $\underline{\mathbb{E}} = \min_i\{\underline{\mathbb{E}}_i\}$ . Similarly, let  $\overline{\mathbb{E}}_i = \sup\{\mathbb{E}(f_i + a_i | f_i)\}$ , and let  $\overline{\mathbb{E}} = \max_i\{\overline{\mathbb{E}}_i\}$ .

*Step (iii): consumers browse at all  $f_i$  for which  $\mathbb{E}(f_i + a_i | f_i) > \min_{j \neq i} \underline{\mathbb{E}}_j$ .* Since total prices are strictly below valuations, consumers always strictly prefer buying over not buying. Consequently, consumers strictly benefit from browsing if with positive probability some rival sets a price  $f_j$  for which  $\mathbb{E}(f_j + a_j | f_j) < \mathbb{E}(f_i + a_i | f_i)$ .

*Step (iv):  $\overline{\mathbb{E}} = \underline{\mathbb{E}}$ .* Suppose otherwise, i.e.  $\overline{\mathbb{E}} > \underline{\mathbb{E}}$ . Because  $\underline{\mathbb{E}} \geq c$ , whenever some rival sets prices above  $\underline{\mathbb{E}}$ , a firm can earn positive profits. By the same argument as in Step (ii) above, this implies that all firms earn positive profits in equilibrium. If only one firm sets  $\overline{\mathbb{E}}$  with positive probability, this firm earns zero profits when doing so—a contradiction. If two or more firms set  $\overline{\mathbb{E}}$  with positive probability, then one of these firms can deviate and move this probability mass to a price offer  $f_i = \overline{\mathbb{E}} - \bar{a} - \eta$  and  $a_i = \bar{a}$ , which is profitable for sufficiently small  $\eta > 0$ . If no firm has a mass point at  $\overline{\mathbb{E}}$  then consider some firm  $i$  that attains the supremum. Take a sequence of  $f_i$  for

which  $\mathbb{E}(f_i + a_i|f_i) \rightarrow \bar{\mathbb{E}}$ , then the expected profit associated with this sequence converges to zero, contradicting that the firm must earn a given positive equilibrium profit. We conclude that  $\bar{\mathbb{E}} = \underline{\mathbb{E}}$ .

*Step (v):*  $\bar{\mathbb{E}} = \underline{\mathbb{E}} = c$ . Suppose otherwise, then  $\bar{\mathbb{E}} = \underline{\mathbb{E}} > c$ . In this case a firm  $i$  can deviate to a price offer  $f_i = \bar{\mathbb{E}} - \bar{a} - \eta$  and  $a_i = \bar{a}$ , which is profitable for sufficiently small  $\eta > 0$ .  $\square$

**Proof of Proposition 3.** We proceed in two steps. First, we show that in any equilibrium where consumers buy with positive probability, they pay a total price equal  $\min\{v, \bar{t}\}$ . Second, we show that these equilibria exist.

*Step (i):* in any equilibrium where consumers buy with positive probability, they pay a total price  $\min\{v, \bar{t}\}$ . We show first that in any equilibrium where consumers buy, a firm  $i$  that sells to consumers with strictly positive probability charges  $f_i, a_i$ , such that  $f_i + a_i \geq \min\{v, \bar{t}\}$ . Towards a contradiction, suppose there exists a firm  $i$  that sells to consumers with strictly positive probability and charges  $f_i, a_i$  such that  $f_i + a_i < \min\{v, \bar{t}\}$ . Then firm  $i$  can strictly increase profits by charging a larger additional price  $a'_i = \min\{v, \bar{t}\} - f_i$ . Studying consumers continue to buy at this price, and browsing consumers do not observe the increased additional price and continue to buy as well. We conclude that in any equilibrium where consumers buy with positive probability, they buy at a price of at least  $\min\{v, \bar{t}\}$ .

Next, we show that in any equilibrium, consumers do not buy at prices  $f_i, a_i$  such that  $f_i + a_i > \min\{v, \bar{t}\}$ . If  $\min\{v, \bar{t}\} = \bar{t}$ , firms cannot charge a total price strictly larger than  $\bar{t}$ . If  $\min\{v, \bar{t}\} = v$ , consumers are strictly better off when they do not buy from a firm  $i$  that charges  $f_i + a_i > v$ . Studying consumers observe  $f_i + a_i > v$  and do not buy, and if firms with positive probability set prices above  $v$  browsing consumers are strictly better off when studying and only buying if the firm's price is weakly below  $v$ . We conclude that in any equilibrium where consumers buy, they pay a total price  $\min\{v, \bar{t}\}$ .

*Step (ii):* equilibria exist where consumers buy. Suppose all firms charge  $f_i + a_i = \min\{\bar{t}, v\}$ , and other than consumers who browse by assumption, all consumers study and buy if and only if the total price is  $\leq v$ . For  $\bar{t} \leq v$ , browsing consumers buy from the firm they were initially assigned to. For  $\bar{t} > v$ , they do not buy. In case  $\bar{t} \leq v$ , for any (equilibrium or out-of-equilibrium) headline price  $f_i$ , consumers believe that  $a_i = \bar{t} - f_i$ . In case  $\bar{t} > v$ , consumers believe that  $f_i + a_i = v$  for all (equilibrium and out-of equilibrium)  $f_i \leq v$  and for  $f_i > v$  that  $f_i + a_i = \bar{t}$ . Note that the consumers' on-path beliefs are consistent with firms' equilibrium strategies. Given the consumers beliefs, they are indifferent between studying and browsing, and when browsing between purchasing or not purchasing. Hence, the consumer behavior is optimal. And because for all equilibrium and out-of-equilibrium headline prices firms sell only to studying consumers and do so whenever  $f_i + a_i \leq v$ , it is optimal for them to set prices  $f_i + a_i = \min\{\bar{t}, v\}$ .  $\square$

#### Auxiliary results for the proof of Proposition 4.

**Lemma 1.** *In any equilibrium in which low-value browsing consumers with positive probability purchase at a headline price  $f_i$ ,  $A_i(a_i|f_i)$  puts positive weight only on the maximal additional price, and  $\Gamma_i(\gamma_i|\bar{a}, f_i)$  has no mass point on any condition  $\gamma_i \in [0, 1]$ .*

*Furthermore, in any equilibrium satisfying our second equilibrium selection assumption, for any  $f_i \leq v_L$  consumers' belief about  $A_i(a_i|f_i)$  puts positive weight only on the additional price  $\bar{a}$ , and consumers believe that  $\Gamma_i(\gamma_i|f_i) = \Gamma_i(\gamma_i|\bar{a}, f_i)$  has no mass point.*

*Proof.* Because the choice of  $\gamma_i$  does not affect profits from high-value browsing or studying consumers and the profits from studying low-value consumers, it suffices to consider the profits a firm earns in equilibrium for browsing low-value consumers to determine the optimal set of distributions  $\Gamma_i(\gamma_i|a_i, f_i)$ .

We first argue that if in equilibrium browsing low-value consumers purchase from firm  $i$  with positive probability at a headline price  $f'_i$ , then  $A_i(a_i|f'_i)$  puts probability one on  $\bar{a}$ . Suppose otherwise, that is the firm set some other additional prices with positive probability. Then firm  $i$  could deviate and move all probability mass from  $A_i(a_i|f'_i)$  and  $\Gamma_i(\gamma_i|a_i, f'_i)$  to a pair  $(\gamma', \bar{a})$  for some  $\gamma'$  that low-value browsing consumers select with probability zero conditional on browsing and purchasing at  $f_i$ . Since low-value consumers buy and  $v_H - v_L > \bar{a}$ , high-value studying consumers will continue to buy after the increase of the additional price. Hence,  $A_i(a_i|f'_i)$  puts probability mass one on  $\bar{a}$ . Furthermore,  $\Gamma_i(\gamma_i|\bar{a}, f'_i)$  cannot have a mass point on any condition  $\gamma_i \in [0, 1]$ . Suppose towards a contradiction that  $\Gamma_i(\gamma_i|\bar{a}, f'_i)$  has at least one mass point, say at  $\gamma'_i$ . If  $\Gamma_i(\gamma_i|\bar{a}, f'_i)$  has multiple mass points, consider those  $\gamma'_i$  among the mass points that have the largest probability mass conditional on  $f_i$  and  $\bar{a}$ . Low-value browsing consumers will select a  $\gamma'_i$  and avoid the additional price  $\bar{a}$  with strictly positive probability while browsing. But since these consumers do not observe  $\gamma_i$ , firm  $i$  can increase profits by shifting the probability mass away from  $\gamma'_i$ . Browsing low-value consumers will now pay  $\bar{a}$  with a larger probability, which increases profits. We conclude that,  $\Gamma_i(\gamma_i|\bar{a}, f_i)$  has no mass point on any condition  $\gamma_i \in [0, 1]$ .

We have thus shown that conditional on low-value browsing consumers buying with positive probability at a headline price  $f_i$ , it is optimal for firm  $i$  to charge  $\bar{a}$  and that  $\Gamma_i(\gamma_i|\bar{a}, f_i)$  has no mass point. Our equilibrium-selection assumption imposes that if consumers observe an off-equilibrium  $f_i \leq v_L$ , consumers believe the choice of  $A_i(a_i|f_i)$  and  $\Gamma_i(\gamma_i|a_i, f_i)$  to be profit-maximizing conditional on some consumers purchasing for whom the choice matters. Sequential rationality implies that studying low-value consumers never pay a positive additional price, and that high-value (studying or browsing) consumers will not fulfill a condition other than their ideal and purchase at any feasible additional price  $\bar{a}$ . Finally, the realization of  $a_i, \gamma_i$  does not affect the purchase decision from browsing low-value consumers because they cannot observe this choice. Hence, consumers must believe that  $\Gamma_i(\gamma_i|f_i) = \Gamma_i(\gamma_i|\bar{a}, f_i)$  has no mass point (which maximizes profits from browsing low-value consumers, and is irrelevant for profits earned from all other subset of consumers) and that the additional price equals  $\bar{a}$ .  $\square$

Because consumers believe that  $\Gamma_i(\gamma_i|\bar{a}, f_i)$  has no mass point, consistency of beliefs requires that it does not have a mass point on the path of play, so firms must choose some continuous distribution on the path of play. Furthermore, when a firm deviates, it is always optimal to deviate to a  $\gamma_i$  that browsing consumers do not avoid with positive probability. Our belief refinement, hence, implies that low-value consumer cannot believe that they can guess  $\gamma_i$  for any  $f_i \leq v_L$  (including ones not on the path of play). To simplify the exposition, we hence from now simply assume that only studying low-value consumers (can) match the firms  $\gamma_i$ , and because high-value consumers never want to choose a different  $\gamma_i$  than their preferred one, we simply suppress  $\Gamma_i(\gamma_i|\bar{a}, f_i)$  in the remainder of the appendix.

**Lemma 2.** *If consumers who browse offers see two headline prices, the second price can be of each*

competitor with positive probability, and at least two firms are assigned a strictly positive share of initial customers, then all firms earn strictly positive profits.

*Proof.* We proceed in three steps. First, we establish a lower bound on headline prices. Second, using this bound we show by contradiction that firms with a positive share of initial consumers earn strictly positive profits. Third, we prove that this implies strictly positive profits for all firms.

*Step (i): Lower bound on headline prices.* Note that all firms almost surely set prices  $f_i \geq c - \bar{a}$ . Otherwise, at least one firm would earn strictly negative profits for prices below  $c - \bar{a}$ .

*Step (ii): Firms with a positive share of initial consumers earn strictly positive profits.* To prove that firms with a positive share of initial consumers earn strictly positive profits, suppose otherwise. Then there exists a firm  $i$  that earns zero profits whose headline price is visible to its share of initial high- and low-value consumers.

Zero profits of firm  $i$  imply that all low-value consumers browse headline prices for  $f_i = c + \eta$  for all  $\eta > 0$  and then buy from the rival they see, since otherwise firm  $i$  could earn positive profits by setting these prices. But this requires that all other firms charge  $f_{-i} + a_{-i} = c$  with probability one, since otherwise there exists a sufficiently small  $\eta$  such that the low-value consumers of firm  $i$  strictly prefer studying and avoiding  $\bar{a}$  when firm  $i$  sets  $f_i = c + \eta$ .  $f_{-i} + a_{-i} = c$  implies that in any candidate equilibrium in which firm  $i$  earns zero profits, all other firms earn zero profits as well. Because we have two firms that are initially assigned consumers, by iterating the above argument, firm  $i$  also must set a total price  $f_i + a_i = c$ . Furthermore, any firm that sells to browsing high-value consumers conditional on charging  $f_i, a_i$  must set an additional price of  $a_i = \bar{a}$  when doing so; otherwise, firm  $i$  could deviate and increase  $a_i$  to  $\bar{a}$ , which does not affect the probability of selling to browsing consumers (who cannot condition their purchase behavior on  $a_i$ ) and does not alter the probability of selling to studying consumers (since low-value consumers simply avoid any positive  $a_i$  and high-value consumers are willing to pay  $f_i + \bar{a} \leq c + \bar{a}$ ). Similarly, any firm selling to studying high-value consumers must set  $a_i = \bar{a}$  because they are still willing to buy at that additional price. And since browsing high-value consumers with positive probability see only the up-front price of a pair of firms  $i, j$  that are initially assigned consumers, one of these firms must sell to high-value consumers and thus set  $\bar{a}$  with probability one, and hence charge  $f_i = c - \bar{a}, a_i = \bar{a}$  with positive probability. Firm  $i$  can only break even if its initially assigned low-value consumers browse rather than study and avoid paying the additional price. But the low-value consumers assigned to firm  $i$  are only willing to do so if browsing leads them to pay in expectation total prices weakly less than  $c - \bar{a}$ , a contradiction. We conclude that all firms with a positive share of initial consumers earn strictly positive profits.

*Step (iii): All firms earn strictly positive profits.* We already know that all firms with a positive share of initial consumers earn strictly positive profits. Hence, with probability one they must set a total price  $t > c$ . Let firm  $i$  be a firm that is assigned some initial consumers, and let  $t_{min}$  be the infimum of the support of firm  $i$ 's total price distribution  $f_i + a_i$ . Then any rival  $j$  that has no consumers initially assigned to it can ensure strictly positive demand by charging  $f_j = t_{min} - \bar{a} - \eta, a_j = \bar{a}$ , because in that case browsing high-value consumers initially assigned to

firm  $i$  will strictly prefer to buy from firm  $j$  when seeing its offer. For sufficiently small  $\eta$ , the total price of firm  $j$  is greater than  $c$ , and because firm  $j$  only serves browsing consumers, all of firm  $j$ 's consumers pay this total price. We conclude that all firms earn strictly positive profits.  $\square$

**Lemma 3.** *Suppose that the first equilibrium-selection assumption holds, and there are at least two firms that are initially assigned a strictly positive fraction of consumers. If consumers who browse draw the second headline price from all other firms with strictly positive probability, then in equilibrium high-value consumers browse with probability one.*

**Proof of Lemma 3.** We proceed in five steps. We show first that at any profit-maximizing headline price offer, at least browsing high-value consumers must be willing to purchase. Second, we establish that  $a_i = \min\{v_H - f_i, \bar{a}\}$  for any optimal  $f_i$  at which high-value consumers buy with positive probability. Third, we prove that  $f_{max} \leq v_L$ . Fourth, we prove that there is no mass point at  $f_{min}$  in any firms' headline price distribution, and that at least two firms must attain  $f_{min}$ . Finally, we conclude that all high-value consumers browse with probability one.

*Step (i): At any profit-maximizing headline price offer, at least browsing high-value consumers must be willing to purchase.* By Lemma 2 firms earn positive profits, and hence with probability one must set profit-maximizing prices  $f_i, a_i$  at which some consumers buy. In case  $f_i \leq v_L$ , a high-value consumer prefers the offer  $f_i, a_i$  to her outside option since  $f_i + a_i \leq v_L + \bar{a} < v_H$ . For  $f_i > v_L$ , low-value consumers never buy. In case a firm sets  $f_i > v_L$  and  $f_i + a_i > v_H$  studying high-value consumers also do not buy, and hence browsing high-value consumers must (i.e.  $f_i + \mathbb{E}(a_i|f_i) \leq v_H$ , where the expectation is taken with respect to the equilibrium price distribution). In case a firm sets  $f_i > v_L$  and  $f_i + a_i \leq v_H$  with probability one, browsing high-value consumers are willing to purchase. Thus, at any profit-maximizing headline price offer, at least browsing high-value consumers must be willing to purchase, that is .

*Step (ii):  $a_i = \min\{v_H - f_i, \bar{a}\}$  for any optimal  $f_i$  at which high-value consumers buy with positive probability.* Consider an  $f_i$  in the support of firm  $i$ 's headline price distribution, and let  $A_i(a_i|f_i)$  be the corresponding conditional equilibrium price distribution over  $a_i$ . A firm  $i$ 's strategy is a collection  $(G_i, \{A_i\}_{f_i})$ , where  $G_i$  is a cumulative distribution function over headline prices, and  $\{A_i\}_{f_i}$  a set of conditional additional price distributions. In equilibrium, with probability one each firm chooses a profit-maximizing pair  $f_i, A_i(\cdot|f_i)$ , and we from now on restrict attention to such profit-maximizing combinations. Consider any headline price for which high-value consumers buy from firm  $i$  with positive probability conditional on firm  $i$  choosing  $f_i$ . We establish that the corresponding  $A_i(\cdot|f_i)$  puts mass one on  $a_i = \min\{v_H - f_{min}, \bar{a}\}$ .

To see this, we first rule out that  $a_i < \min\{v_H - f_i, \bar{a}\}$  with positive probability. In this case, firm  $i$  can move probability mass from an interval  $(0, a'_i)$  to  $a'_i$ , with  $a'_i < \min\{v_H - f_i, \bar{a}\}$ . This does not affect the demand from any consumer who browses headline prices; it also does not lower demand from low-value consumers who study the fine print because they can costlessly avoid paying the additional price; and it also does not lower demand from high-value consumers who study the fine print because they still prefer purchasing the product. Hence, this change increases expected profits, contradicting that  $f_i, A_i(\cdot|f_i)$  was profit-maximizing.



We next rule out  $A_i(\cdot|f_i)$  puts positive probability weight on additional prices  $a_i \in (v_H - f_i, \bar{a}]$ . Suppose otherwise. Then the expected value of  $a_i$  conditional on  $f_i$  is greater than  $v_H - f_i$ . Hence, high-value consumers will not purchase without studying the fine print, and upon investigating it purchase only if  $a_i \notin (v_H - f_i, \bar{a}]$ . Furthermore, low-value consumers cannot be buying because  $f_i > v_H - \bar{a} \geq v_L$ . Thus, high-value consumers must be studying fine print with positive probability because otherwise firms would not sell in equilibrium, which we ruled out above. Hence, firm  $i$  could increase profits by moving the probability mass from the interval  $(v_H - f_i, \bar{a}]$  to  $v_H - f_i$ , a contradiction. We conclude that  $A_i(\cdot|f_i)$  puts probability one on the additional price  $a_i = \min\{v_H - f_i, \bar{a}\}$  for any optimal  $f_i$  at which high-value consumers buy with positive probability.

Before continuing, we introduce some notation. Let  $\underline{f}_i$  be the infimum of firm  $i$ 's headline price distribution and let  $f_{min} = \min_i\{\underline{f}_i\}$ . Similarly, let  $\bar{f}_i$  be the supremum of firm  $i$ 's headline price distribution and let  $f_{max} = \max_i\{\bar{f}_i\}$ .

*Step (iii):*  $f_{max} \leq v_L$ . Suppose otherwise, i.e.  $f_{max} > v_L$ . Low-value consumers do not but at any headline price  $f_j > v_L$ . We will now argue that a firm charging at or sufficiently close to  $f_{max}$  cannot earn its equilibrium profits. Suppose at least two firms have a mass point at  $f_{max}$ . Then any such firm must sell to high-value consumers and set an additional price of  $a_{high} = \min\{v_H - f_{max}, \bar{a}\}$ . But then a firm could discretely increase its demand from browsing high-value consumers by setting  $f_j = f_{max} + a_{high} - \bar{a} - \eta$  and  $a_j = \bar{a}$ , which is profitable for sufficiently small  $\eta > 0$ —a contradiction.

If only one firm has a mass point at  $f_{max}$  and charges a total price less than  $v_H$ , high-value consumers get a better deal for certain when browsing, and hence must do so. But this implies that the firm has no demand, and hence does not earn its positive equilibrium profits. Hence, it must charge a total price of  $v_H$  with positive probability, and some rival must also charge a total price of  $v_H$  with positive probability. But then by essentially the same argument as above where two or more firms have a mass point at  $f_{max}$ , there is a profitable deviation.

Now suppose no firm has a mass point at  $f_{max}$ . Consider a firm  $j$  that has  $f_{max}$  as a supremum over its headline price distribution, and consider a sequence of prices  $f_j$  at which high-value consumers buy and that converges to  $f_{max}$ . There are two subcases to consider. If  $f_{max} + \bar{a} \leq v_H$ , then as  $f_j \rightarrow f_{max}$ , firm  $j$  charges a higher total price than all other firms with a probability that approaches one, and hence all high-valuation consumers must browse, which in turn implies that the expected demand of firm  $j$  converges to 0. Thus,  $j$  cannot earn its equilibrium profits in this subcase. If, on the other hand,  $f_{max} + \bar{a} > v_H$  then for an interval of prices sufficiently close to  $f_{max}$ , firm  $j$  charges a total price of  $v_H$ . If some other firm also charges a total price of  $v_H$  with positive probability, deviating to a price offer  $f_j = v_H - \bar{a} - \eta$  and  $a_j = \bar{a}$  is profitable for sufficiently small  $\eta > 0$ . In case no other firm charges a total price of  $v_H$  with positive probability, high-value consumers strictly prefer to browse for the headline prices that induce a total price of  $v_H$ , and hence  $j$  does not earn its equilibrium profits. We conclude that  $f_{max} \leq v_L$ .

*Step (iv):* there is no mass point at  $f_{min}$  in any firms' headline price distribution, and at least two firms must attain  $f_{min}$ . Note that high-valuation consumers must buy at  $f_{min}$  so that a firm

that has a mass point at  $f_{min}$  sets an additional price  $a_i = \bar{a}$  whenever it charges  $f_{min}$ . Suppose at least two firms have a mass point at  $f_{min}$ . Then one of these firms  $i$  can increase profits by shifting probability mass from the mass point to the pair  $f_i = f_{min} - \eta$  and  $a_i = \bar{a}$  for some  $\eta > 0$ . This discretely increases demand from browsing high-value consumers; furthermore, since upon observing the headline price consumers know that deviant offer is better, it cannot lower demand from any other consumer group. To see that this deviation is profitable for a sufficiently low  $\eta$ , it remains to establish that the deviant firm cannot loose through inducing low-value consumers that are initially assigned to it, to study and save on the additional price. Observe, however, that if  $f_{min} < v_L$  low-value consumers must study conditional on observing  $f_{min}$ , as this guarantees the lowest possible expenditure. Hence, since  $f_{min} < v_L$ , the loss from low-value consumers is bounded by  $\eta$ . In case  $f_{min} = v_L$  a browsing low-value consumer does not buy, and the firm can choose  $\eta$  such that  $f_{min} - \eta > c$  in which case inducing low-value consumers to study and buy further increase profits. Hence, there can be at most one firm with a mass point at  $f_{min}$ .

To rule this out, suppose  $i$  has a mass point at  $f_{min}$ . Recall that at  $f_{min}$  low-value consumers that are initially assigned to firm  $i$  must study. We first argue that  $\min_{j \neq i} \{f_j\} = f_{min}$ , for otherwise firm  $i$  could deviate to  $f_i \in (f_{min}, \min\{\min_{j \neq i} \{f_j\}, v_L\})$  and  $a_i = \bar{a}$ . At such a headline price low-value consumers initially assigned to firm  $i$  still prefer to study and buy from firm  $i$ , and any high-value browsing consumer still prefers firm  $i$ 's offer to any alternative offer that they accept in equilibrium, as well as their outside option. Hence, all browsing high-value consumers still buy from firm  $i$  with probability one. To evaluate the response of low-value consumers to this price increase, we now consider three subcases: (a)  $f_{min} + \bar{a} < v_L$ ; (b)  $f_{min} + \bar{a} > v_L$ ; and (c)  $f_{min} + \bar{a} = v_L$ . In subcase (a) for  $f_i \in (f_{min}, v_L - \bar{a})$ , browsing low-value consumers still buy after the headline price increase, and hence the firm loses no demand when raising its price, a contradiction. In subcase (b) browsing low-value consumers do not buy, and hence the price increase does not affect demand, again implying that it is profitable. In subcase (c), a browsing low-value consumer cannot receive a positive surplus. Hence, the surplus of a low-value consumer who does not study is zero, and thus low-value consumers strictly prefer to study for all headline prices  $f_i \in (f_{min}, v_L)$ . So raising the price to just below  $\min\{\min_{j \neq i} \{f_j\}, v_L\}$  is profitable. We conclude that  $\min_{j \neq i} \{f_j\} = f_{min}$ .

Now consider a rival  $j$  for whom  $f_j = f_{min}$ . Hence, in equilibrium firm  $j$  charges headline prices in an interval  $(f_{min}, f_{min} + \eta)$  for any  $\eta > 0$ . Since at most one firm has a mass point at  $f_{min}$ ,  $f_{max} > f_{min}$ , and thus  $v_L > f_{min}$ . Consider sufficiently small  $\eta > 0$  that satisfy  $\eta < \min\{v_L - f_{min}, \bar{a}\}$ . We first establish that if  $\eta$  is sufficiently small, low-value consumers initially assigned to firm  $j$  study with probability one for all profit-maximizing equilibrium headline prices in  $(f_{min}, f_{min} + \eta)$ . Suppose not. Then a positive fraction of these consumers browse. If either the browsing low-value or browsing high-value consumers buy with positive probability from firm  $j$ , then the additional price must satisfy  $a_j = \min\{v_H - f_{min}, \bar{a}\} = \bar{a}$ . Consider such price pairs  $f_j, \bar{a}$  of firm  $j$  for which low-value consumers browse. Furthermore, as  $\eta \rightarrow 0$ , the probability of a firm  $l \neq i, j$  setting a headline price  $f_l > f_{min} + \eta$  goes to 1, and the probability of firm  $l$  setting a headline price in the interval  $(f_{min}, f_{min} + \eta)$  goes to 0. (Trivially, when  $I = 2$ , the probability that a third firm charges a price in  $(f_{min}, f_{min} + \eta)$  is zero for any  $\eta > 0$ .) Note that a low-value consumer who sees a headline price in the interval  $(f_{min}, f_{min} + \eta)$  is strictly better off studying whenever it is matched with a headline price at or above  $f_{min} + \eta$ ; with positive probability, however, a browsing low-value

consumer initially assigned to firm  $j$  is matched with firm  $i$  when it charges  $f_{min}$  and in that case loses a payoff of at least  $\bar{a} - \eta$  relative to studying; finally, the probability of being matched with a headline price in  $(f_{min}, f_{min} + \eta)$  goes to zero, so that for sufficiently small  $\eta$  low-value consumers initially assigned to firm  $j$  strictly prefer studying. We conclude that low-value consumers initially assigned to firm  $j$  study with probability one for all profit-maximizing equilibrium headline price in  $(f_{min}, f_{min} + \eta)$ . But this implies a profitable deviation for firm  $j$ . If firm  $j$  deviates and charges  $f_j = f_{min} - \eta$ ,  $a_j = \bar{a}$  it keeps all consumers initially assigned to it and loses at most  $2\eta$  from any consumer it sells to, and attracts all browsing consumers that are matched with it. Since firm  $i$  charges  $f_{min}$  with positive probability, this strictly increases demand, and hence is profitable for sufficiently small  $\eta$ . We conclude that there is no mass point in the headline price distribution at  $f_{min}$ .

We prove now that at least two firms must attain the infimum  $f_{min}$ . Suppose otherwise that  $\underline{f}_i = f_{min}$  for only one firm  $i$ . Then there exists an  $\eta$  such that only firm  $i$  sets prices in  $(f_{min}, f_{min} + \eta)$  with probability one. Browsing high-value consumers buy from firm  $i$  for headline prices in  $(f_{min}, f_{min} + \eta)$  with positive probability, so that  $a_i = \bar{a}$  for these prices. But then firm  $i$  could increase profits from all consumers buying at prices in  $(f_{min}, f_{min} + \eta)$  by shifting all probability mass from this interval to just below  $f_{min} + \eta$ , a contradiction. We conclude that  $\underline{f}_i = f_{min}$  for at least two firms  $i$ .

*Step (v): All high-value consumers browse with probability one.* It follows from Step (iii) that there is no benefit of studying for high-value consumers since they buy and do not avoid the additional price, and furthermore by Step (ii) high-value consumers pay  $\bar{a}$ . At any headline price above  $f_{min}$ , hence, they strictly benefit from browsing by Step (iv), and since there is no mass point at  $f_{min}$ , high-value consumers browse with probability one.  $\square$

**Lemma 4.** *Suppose there are  $N \geq 2$  firms each of which is assigned an initial share of  $1/N$  of consumers. Let  $I = N$  or  $I = N + 1$  (i.e. there is at most one additional firm that has no consumers assigned to it). If consumers who browse draw the second headline price from all other firms with equal probability, then in any equilibrium that satisfies our equilibrium-selection assumptions, firms that have initially assigned consumers earn the same profits and play symmetric headline-price strategies, and low-value consumers study with probability one. Furthermore, the symmetric headline-price equilibrium distribution of the firms that have initially assigned consumers has no mass points.*

**Proof of Lemma 4.** We use the same notation as in the proof of Lemma 3; that is, let  $\underline{f}_i$  be the infimum of firm  $i$ 's headline price distribution and let  $f_{min} = \min_i \{\underline{f}_i\}$ . Similarly, let  $\bar{f}_i$  be the supremum of firm  $i$ 's headline price distribution and let  $f_{max} = \max_i \{\bar{f}_i\}$ .

We proceed in five steps. First, we establish that our second equilibrium-selection assumption implies that  $a_i = \min\{v_H - f_i, \bar{a}\}$ , and that for any  $f_i \leq v_H - \bar{a}$  (on or of the equilibrium path), consumers believe that  $a_i = \bar{a}$  with probability one. Second, we prove that  $f_{max} \leq v_H - \bar{a}$ . Third, we show that for any headline price at which low-value consumers weakly prefer to browse, the firm would earn higher profits if low-value consumers switched to studying instead. Fourth, we establish

that firms that are initially assigned consumers that attain  $f_{min}$  or  $f_{max}$  earn the same profits, and use the same price distributions. Fifth, we prove that all firms with initially assigned consumers attain  $f_{min}$ .

*Step (i):*  $a_i = \min\{v_H - f_i, \bar{a}\}$ , and that for any  $f_i \leq v_H - \bar{a}$  (on or of the equilibrium path), consumers believe that  $a_i = \bar{a}$  with probability one. We focus on equilibria in which, by our second equilibrium-selection assumption, consumers who observe an off-equilibrium headline price by firm  $i$  believe that  $a_i, \gamma_i$  are profit-maximizing conditional on an arbitrarily small share of both high- and low-value consumers buying from firm  $i$ —that is some consumer of each type are either browsing and buying from firm  $i$  or studying and then making an optimal purchase decision. For  $a_i > 0$  to be optimal, firms can ignore low-value studying consumers since they never collect a positive additional price from them. For browsing consumers,  $a_i = \bar{a}$  is optimal since they do not see the additional price. For high-value consumers who study,  $a_i = \min\{v_H - f_i, \bar{a}\}$  is optimal. Therefore consumers must believe that  $a_i \geq \min\{v_H - f_i, \bar{a}\}$ . Thus, for any  $f_i \leq v_H - \bar{a}$  (on or of the equilibrium path), consumers believe that  $a_i = \bar{a}$  with probability one.

*Step (ii):*  $f_{max} \leq v_H - \bar{a}$ . We next show that  $f_{max} \leq v_H - \bar{a}$ . Suppose not. Then since  $f_{max} > v_L$  low-value consumers do not buy at or close to  $f_{max}$ . Furthermore, high-value consumers browse with probability one by Lemma 3, and a firm selling only to browsing high-value consumers must set  $a_i = \bar{a}$ ; but since  $f_{max} + \bar{a} > v_H$  this implies that no consumer buys at headline prices sufficiently close to  $f_{max}$ , contradicting that firms earn positive profits by Lemma 2. We conclude that  $f_{max} \leq v_H - \bar{a}$ . This implies that  $a_i = \bar{a}$  for almost all equilibrium price offers, and that consumers believe that  $a_i = \bar{a}$  for any price offer  $f_i \leq f_{max}$ .

*Step (iii):* For any headline price at which low-value consumers weakly prefer to browse, the firm would earn higher profits if low-value consumers switched to studying instead. We next establish that for any headline price at which low-value consumers weakly prefer to browse, the firm would earn higher profits if low-value consumers switched to studying instead. To see this, we denote by  $1 - H_{-j}(f_j) = \frac{1}{I-1} \sum_{i \neq j} \mathbb{P}(f_i > f_j)$  the probability that the average competitor charges a strictly larger headline price than firm  $j$  and by  $1 - H_{-j}^-(f_j) = \frac{1}{I-1} \sum_{i \neq j} \mathbb{P}(f_i \geq f_j)$  the corresponding probability for a weakly larger one. Note that  $H_{-j}(f_j) = H_{-j}^-(f_j)$  if no competitor has a mass point at  $f_j$ . Since for any  $f_j \leq f_{max}$  consumers believe that  $a_j = \bar{a}$ , low-value consumers weakly prefer to browse at such a headline price  $f_j$  if and only if

$$\underbrace{f_j}_{\text{price when studying}} \geq \underbrace{(1 - H_{-j}(f_j))(f_j + \bar{a})}_{\text{browse larger price}} + \underbrace{[H_{-j}(f_j) - H_{-j}^-(f_j)](f_j + \bar{a})}_{\text{browse identical price}} + \underbrace{H_{-j}^-(f_j)[\mathbb{E}(f_{-j}|f_{-j} < f_j) + \bar{a}]}_{\text{browse smaller price}},$$

which is equivalent to

$$\bar{a} \leq H_{-j}^-(f_j)[f_j - \mathbb{E}(f_{-j}|f_{-j} < f_j)].$$

Firm  $j$ 's profit when a low-valuation consumer studies, i.e.  $f_j - c$ , is greater than the profit it earns

from the low-value consumer browsing if

$$f_j - c > (1 - H_{-j}(f_j))(f_j + \bar{a} - c) + \frac{H_{-j}(f_j) - H_{-j}^-(f_j)}{2}(f_j + \bar{a} - c) + H_{-j}^-(f_j) \times 0,$$

where the second term on the right-hand-side uses our tie-breaking rule. Hence, since  $f_j + \bar{a} > c$ , a sufficient condition for the firm preferring the consumer to study is

$$f_j - c > (1 - H_{-j}^-(f_j))(f_j + \bar{a} - c),$$

which is equivalent to

$$\bar{a} < H_{-j}^-(f_j)[f_j - (c - \bar{a})].$$

Since firms must earn positive profits, headline prices are strictly greater than  $c - \bar{a}$ , and hence  $\mathbb{E}(f_{-j} | f_{-j} < f_j) > c - \bar{a}$ , which implies that the firm strictly prefers consumers to study whenever they weakly prefer to browse.

*Step (iv): Firms that are initially assigned consumers that attain  $f_{min}$  or  $f_{max}$  earn the same profits, and use the same price distributions.* We first rule out that two (or more) firms have a mass point at  $f_{max}$ . In that case, high-value consumers must buy from one of these firms with positive probability, and this firm must set  $a_i = \bar{a}$ . Then another firm  $j$  setting  $f_{max}$  would be strictly better off setting  $f_j = f_{max} - \eta$  and  $a_j = \bar{a}$  for a sufficiently small  $\eta > 0$ . In this case, it attracts the browsing high-value consumers when firm  $i$  charges  $f_{max}$  and they see firm  $i$  and  $j$ 's headline prices. Furthermore, our second equilibrium-selection assumption implies that all consumers believe that  $a_i = \bar{a}$  with probability one. If low-value consumers strictly preferred to browse, then they still strictly prefer to browse after a small price cut. If they strictly preferred to study, they must still strictly prefer to study. And if the low-value consumers were indifferent between studying and browsing, then they strictly prefer to study following the headline price decrease because they think  $a_i = \bar{a}$ ; and such a switch is beneficial to firm  $j$ . We conclude that at most one firm has a mass point at  $f_{max}$ .

Let  $h$  be a firm that has the mass point at  $f_{max}$ , or attains the supremum of the headline price distribution  $f_{max}$  if no firm has a mass point at  $f_{max}$ . Since high-value consumers browse, this firm must sell to low-value studying consumers at (or arbitrarily close to)  $f_{max}$ . This implies that firm  $h$  is one of the  $N$  firms, which have consumers initially assigned to it, and that the low-value consumers weakly prefer to study when firm  $h$  sets  $f_{max}$ .

Let  $\pi_h$  be the equilibrium profits of firm  $h$ . It follows from the proof of Lemma 3 that no firm has a mass point at  $f_{min}$ , and at least two firms obtain  $f_{min}$ . Let  $l$  be a firm that attains  $f_{min}$  and belongs to the group  $N$  of firms that have consumers initially assigned to it. Let  $\pi_l$  be its equilibrium profits. We next establish that  $\pi_h = \pi_l$ . This holds trivially if  $l = h$ . Hence, suppose that  $l \neq h$ .

We show that low-value consumers that see firm  $l$ 's headline price study for all headline prices below  $f_{max}$ , including out-of-equilibrium ones. Suppose otherwise. Then since low-value consumers believe that  $a_l = \bar{a}$  for these headline prices, and studying is optimal at  $f_{min}$ , there exists some headline price  $f_{min} < \hat{f}_l < f_{max}$  at which consumers are indifferent between studying and browsing.

First, we establish that if  $\hat{f}_l > \underline{f}_h > f_{min}$ , then  $\pi_l > \pi_h$ . The reason is that if firm  $l$  charges  $\underline{f}_h$  (or minimally undercuts it), then it earns as much as firm  $h$  does when doing so from browsing consumers that are initially assigned to a firm  $i \neq h, l$ , and it earns as much from low-value consumers initially assigned to itself as firm  $h$  does from its initially assigned low-value consumers because low-value consumers study at this price. But  $l$  earns more from high-value consumers that browse and are matched with firm  $h$  than firm  $h$  does from browsing high-value consumers matched with firm  $l$ , because firm  $h$  charges higher prices with probability one. This, however, is a contradiction because by charging  $f_{min}$  firm  $h$  could earn at least firm  $l$ 's equilibrium profits—both firms make the same profits from low-value studying consumers, both earn the same from browsing consumers of firms  $i \neq h, l$ , both earn the same from high-value browsing consumers assigned to the other firm, and since none of firm  $h$ 's initially-assigned low-value consumers browse,  $l$  earns weakly less from browsing low-value consumers. This rules out that  $\hat{f}_l > \underline{f}_h > f_{min}$ .

We next rule out that  $\underline{f}_h \geq \hat{f}_l$ . Since low-value consumers of firm  $l$  are indifferent between studying and saving  $\bar{a}$  and browsing for the chance of getting a lower headline price from a firm  $i \neq l, h$  (since  $h$  always charges weakly higher headline prices) at  $\hat{f}_l$ , low-value consumers of firm  $h$  strictly prefer to browse because firm  $l$  with positive probability charges lower headline prices. But this contradicts the fact that low-value consumers of firm  $h$  weakly prefer to study at  $f_{max}$ , which saves them  $\bar{a}$  but forgoes the chance of a bigger price savings from a firm  $i \neq h, l$  as well as a potential cheaper headline price from firm  $l$ . We conclude that  $\underline{f}_h = f_{min}$  and firm  $h$  earns  $\pi_l$ .

The fact that firm  $h$  earns  $\pi_l$  implies that for all prices below  $f_{max}$  it earns at most  $\pi_l$ . This implies that below  $\hat{f}_l$ , where low-value consumers of both firms study, it must be weakly more likely to be undercut by firm  $l$ , i.e.  $H_{-h}(f) \geq H_{-l}(f)$ . But this in turn implies that at a price  $\hat{f}_l$  the benefit from browsing is weakly greater for the consumers of firm  $h$  than for those of firm  $l$ , and so low-value consumers of firm  $l$  must study at all prices. We conclude that  $\hat{f}_l \geq f_{max}$ , so that low-value consumers study at all prices below  $f_{max}$ .

We next show that  $\pi_l = \pi_h$ . First, firm  $h$  earns as much as firm  $l$  when charging  $f_{min}$ , so that  $\pi_h \geq \pi_l$ . Furthermore, firm  $l$  must earn at least as much as firm  $h$  (i.e.  $\pi_l \geq \pi_h$ ), as otherwise firm  $l$  could deviate and minimally undercut  $f_{max}$  and earn profits arbitrarily close to  $\pi_h$ . We conclude that  $\pi_l = \pi_h$ .

Next, note that neither firm  $h$  nor firm  $l$  can have a mass point, because then the other of the two firms would earn higher profits by minimally undercutting the mass point. Furthermore, since  $\pi_l = \pi_h$ , at all equilibrium prices  $H_{-h}(f) = H_{-l}(f)$ , that is firm  $l$  and  $h$  use the same price distribution.

*Step (v): All  $N$  symmetric firms that are initially assigned consumers must attain  $f_{min}$ .* Suppose towards a contradiction that there is a firm  $i$  among this group of firms that does not attain  $f_{min}$ , i.e.  $\underline{f}_i > f_{min}$ . We now show this implies  $\pi_l > \pi_i$ . Consider the profits from firm  $l$  setting  $f_l = \underline{f}_i - \eta$  and  $a_l = \bar{a}$ . Firm  $l$  attracts weakly more browsing consumers of firms  $j \neq \{i, l\}$  than firm  $i$  does, and earns no more than  $\eta$  less per browsing consumer it attracts. Since at any headline price at which low-value consumers prefer to browse firms earn larger profits when they study and since low-value consumers of firm  $l$  study with probability one, firm  $l$ 's profit from a low-value consumer initially assigned to it is at most  $\eta$  less. Similarly, firm  $l$  earns at most  $\eta$  less

from attracting a browsing high-value consumer of firm  $i$  than what firm  $i$  earns when attracting a browsing high-value consumer from firm  $l$ . But crucially, with probability one firm  $l$  attracts all browsing consumers from firm  $i$  when matched with it because it undercuts firm  $i$ 's lowest headline price. In contrast, because in equilibrium firm  $l$  sets prices  $f_l < \underline{f}_i$  with strictly positive probability, firm  $i$  attracts the browsing high-value consumers of firm  $l$  with a probability strictly bounded away from one. Thus for sufficiently small  $\eta$ ,  $\pi_l > \pi_h$ . But firm  $i$  could deviate an set  $f_{min}$  in which case it would earn  $\pi_l$ , contradicting that  $\underline{f}_i > f_{min}$ . We conclude that all firms  $i$  that are initially assigned consumers attain  $f_{min}$ , and hence by the above argument for these firms  $H_{-i}(f) = H_{-h}(f)$  and therefore all firms  $i$  that are initially assigned consumers use a symmetric price distribution. And because we established above that the headline price distribution of firm  $h$  does not have a mass point, the symmetric price distribution does not have a mass point. Finally, because low-value consumers study at  $f_{max}$ , they must study with probability one.  $\square$

**Proof of Proposition 4.** We proceed in five steps. First we determine equilibrium profits and price distributions conditional on  $f_{max}$ . Second, we establish that  $f_{max} \leq \min\{E(f) + \bar{a}, v_L\}$ . Third, we show that there exists an  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  if and only if  $\alpha \geq \alpha^*$ . Fourth, we prove that  $f_{max}$  increases in  $\alpha$ . Fifth, we show that profits weakly increase in  $\bar{a}$

*Step (i): Equilibrium profits and price distributions.* By Lemma 2 firms earn positive profits, and hence with probability one must set profit-maximizing prices  $f_i, a_i$  at which some consumers buy. In case  $f_i \leq v_L$ , a high-value consumer prefers the offer  $f_i, a_i$  to her outside option since  $f_i + a_i \leq v_L + \bar{a} < v_H$ . Thus, at any profit-maximizing headline price offer, at least browsing high-value consumers must be willing to purchase, that is  $f_i + \mathbb{E}(a_i|f_i) \leq v_H$ , where the expectation is taken with respect to the equilibrium price distribution.

We now show that firms earn  $\frac{\alpha}{T}(f_{max} - c)$ . Since by Lemma 3 high-value consumers browse and by Lemma 4 the symmetric equilibrium price distribution has no mass point, as  $f_i \rightarrow f_{max}$  the probability that high-value consumers find a cheaper headline price converges to one. Thus, low-value consumers, who study by Lemma 4, must buy with probability one for all  $f_i \in (f_{min}, f_{max})$  as otherwise profits would go to zero as  $f_i \rightarrow f_{max}$ . Since there is no mass point at  $f_{max}$ , this implies that in equilibrium firms must earn  $\frac{\alpha}{T}(f_{max} - c)$ .

We next use standard arguments to show that the support of the equilibrium headline-price distribution is connected. Suppose the support is not connected. Take the largest interval  $(\check{f}, \hat{f}) \subset (f_{min}, f_{max})$  for which the probability that a firm charges a price in that interval is zero. Consider a firm  $i$  that deviates and for a sufficiently small  $\eta > 0$ , moves the probability mass from an interval  $(\check{f} - \eta, \check{f}]$  to  $\hat{f}$ . This loss from browsing high-value consumers is bounded by  $[H_{-i}(\check{f}) - H_{-i}(\check{f} - \eta)]\check{f}$ , while the gain per studying low-value consumer is at least  $\hat{f} - \check{f}$ . Thus, as  $\eta \rightarrow 0$ , the loss per high-value browsing consumer vanishes while the gain from studying low-value consumers is bounded from below by a constant, and thus there exists a profitable deviation. We conclude that the support of the headline price distribution is connected.

Indifference between all prices in the equilibrium price distribution requires that the cumulative

equilibrium price distribution  $G(f)$  satisfies

$$\begin{aligned}\frac{\alpha}{I}(f_{max} - c) &= \frac{\alpha}{I}(f - c) + \frac{(1 - \alpha)}{I}(1 - G(f))(f + \bar{a} - c) + (1 - \frac{1}{I})\frac{(1 - \alpha)}{I - 1}(1 - G(f))(f + \bar{a} - c) \\ &= \frac{\alpha}{I}(f - c) + \frac{2(1 - \alpha)}{I}(1 - G(f))(f + \bar{a} - c).\end{aligned}\quad (1)$$

Hence, one has

$$f_{min} = \frac{\alpha(f_{max} + \bar{a} - c)}{2 - \alpha} + c - \bar{a},$$

and

$$G(f) = 1 - \frac{\alpha(f_{max} - f)}{2(1 - \alpha)(f + \bar{a} - c)} \quad \text{for } f \in [f_{min}, f_{max}]. \quad (2)$$

*Step (ii):*  $f_{max} \leq \min\{E(f) + \bar{a}, v_L\}$ . For low-value consumers to be willing to purchase at  $f_{max}$  after studying, it must be that  $f_{max} \leq v_L$  and that  $f_{max} \leq E(f_{-i}) + \bar{a}$ , where the expectation is taken with regard to the equilibrium headline price distribution  $G(f)$ . Thus,  $f_{max} \leq \min\{E(f) + \bar{a}, v_L\}$ .

*Step (iii):* There exists an  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  if and only if  $\alpha \geq \alpha^*$ . If  $E(f) + \bar{a} \geq v_L$ , we must have  $f_{max} = v_L$  because otherwise the firm can charge a higher headline price at which low-value consumers would still be willing to study and then buy, and hence charging such a headline price would increase profits.

If  $E(f) + \bar{a} < v_L$ , low-value consumers would prefer to browse when seeing headline prices above  $E(f) + \bar{a}$  rather than to study, contradicting the above. In that case, it must be that  $\bar{a} = f_{max} - E(f)$  because for any  $f_{max} < E(f) + \bar{a}$  low-value consumers would still be studying and then buying when facing a slightly higher headline price, and hence there would be a profitable deviation.

Hence in equilibrium  $f_{max} = v_L$  if  $E(f|f_{max} = v_L) + \bar{a} > v_L$ . Integration by parts yields

$$\begin{aligned}E(f) &= \int_0^\infty f \cdot g(f) df \\ &= [fG(f)]_0^{f_{max}} - \int_0^\infty G(f) df \\ &= \int_0^{f_{max}} 1 - G(f) df \\ &= f_{min} + \int_{f_{min}}^{f_{max}} 1 - G(f) df.\end{aligned}\quad (3)$$

Substituting (2) into (3) gives

$$E(f) = f_{min} + \int_{f_{min}}^{f_{max}} \frac{\alpha(f_{max} - f)}{2(1 - \alpha)(f + \bar{a} - c)} df, \quad (4)$$



which is increasing in  $f_{max}$  because

$$\begin{aligned}\frac{\partial E(f)}{\partial f_{max}} &= \frac{\partial f_{min}}{\partial f_{max}} - \frac{\partial f_{min}}{\partial f_{max}} \frac{\alpha(f_{max} - f_{min})}{2(1-\alpha)(f_{min} + \bar{a} - c)} + \int_{f_{min}}^{f_{max}} \frac{\alpha}{2(1-\alpha)(f + \bar{a} - c)} df \\ &= \frac{\partial f_{min}}{\partial f_{max}} G(f_{min}) + \int_{f_{min}}^{f_{max}} \frac{\alpha}{2(1-\alpha)(f + \bar{a} - c)} df > 0.\end{aligned}$$

Hence  $E(f|f_{max} = v_L) + \bar{a} > v_L$  is equivalent to

$$f_{min} + \int_{f_{min}}^{v_L} \frac{\alpha(v_L - f)}{2(1-\alpha)(f + \bar{a} - c)} df > v_L - \bar{a}. \quad (5)$$

Observe that the left-hand side of the above equation is increasing in  $\alpha$ , since

$$\frac{\partial LHS}{\partial \alpha} = \frac{\partial f_{min}}{\partial \alpha} G(f_{min}) + \int_{f_{min}}^{v_L} \frac{\partial}{\partial \alpha} \left[ \frac{\alpha(v_L - f)}{2(1-\alpha)(f + \bar{a} - c)} \right] df > 0.$$

Using that for  $\alpha \rightarrow 1$ ,  $f_{min} \rightarrow f_{max}$  it is easy to verify that indeed  $E(f|f_{max} = v_L) + \bar{a} > v_L$  for  $\alpha$  sufficiently close to one and hence  $f_{max} = v_L$ . To verify that  $E(f|f_{max} = v_L) + \bar{a} < v_L$  when  $\alpha \rightarrow 0$ , we substitute  $f_{min}$  into Inequality (5), which gives

$$\frac{\alpha}{2-\alpha}(v_L + \bar{a} - c) + c - \bar{a} + \frac{\alpha}{2(1-\alpha)} \int_{\frac{\alpha(v_L + \bar{a} - c)}{2-\alpha} + c - \bar{a}}^{v_L} \frac{v_L - f}{f + \bar{a} - c} df < v_L - \bar{a}. \quad (6)$$

Since

$$\int_{\frac{\alpha(v_L + \bar{a} - c)}{2-\alpha} + c - \bar{a}}^{v_L} \frac{v_L - f}{f + \bar{a} - c} df < \int_{\frac{\alpha(v_L + \bar{a} - c)}{2-\alpha} + c - \bar{a}}^{v_L} \frac{v_L}{f + \bar{a} - c} df < [v_L \ln(f + \bar{a} - c)]_{\frac{\alpha(v_L + \bar{a} - c)}{2-\alpha} + c - \bar{a}}^{v_L} = v_L \ln\left(\frac{2-\alpha}{\alpha}\right)$$

one has

$$\begin{aligned}\lim_{\alpha \rightarrow 0} \frac{\alpha}{2(1-\alpha)} \int_{\frac{\alpha(v_L + \bar{a} - c)}{2-\alpha} + c - \bar{a}}^{v_L} \frac{v_L - f}{f + \bar{a} - c} df &\leq \lim_{\alpha \rightarrow 0} \frac{\alpha}{2(1-\alpha)} v_L \ln\left(\frac{2-\alpha}{\alpha}\right) \\ &= \lim_{\alpha \rightarrow 0} v_L \frac{\ln\left(\frac{2-\alpha}{\alpha}\right)}{\frac{2(1-\alpha)}{\alpha}} \\ &= \lim_{\alpha \rightarrow 0} v_L \frac{\alpha}{2-\alpha} = 0,\end{aligned}$$

where the last step follows from L'Hospital's rule. Hence the left hand side of Inequality 6 goes to some value less than  $v_L$  as  $\alpha \rightarrow 0$ , implying that  $E(f|f_{max} = v_L) + \bar{a} < v_L$ . Thus, there exists a critical  $\alpha^* \in (0, 1)$  such that  $f_{max} < v_L$  if and only if  $\alpha < \alpha^*$ .

*Step (iv):  $f_{max}$  increases in  $\alpha$ .* Since all consumers purchase the product for any  $\alpha$ , and hence the cost of production are the same independently of  $\alpha$  it suffices to show that the firms' expected

profits  $\frac{\alpha}{\Gamma}(f_{max} - c)$  are increasing in  $\alpha$ . This holds obviously for any  $\alpha > \alpha^*$ . It remains to show that for any  $\alpha \leq \alpha^*$ ,  $f_{max}$  increases in  $\alpha$ .

For these values of  $\alpha$ ,  $f_{max}$  is implicitly defined by  $f_{max} - E(f) = \bar{a}$ . Using Equation 4 for the expected price  $E(f)$  and applying the implicit-function theorem, we get

$$\frac{\partial f_{max}}{\partial \alpha} = \left[ 1 - \int_{f_{min}}^{f_{max}} \frac{\alpha}{2(1-\alpha)(f + \bar{a} - c)} df \right]^{-1} \cdot \left[ \int_{f_{min}}^{f_{max}} \frac{(f_{max} - f)}{(1-\alpha)^2(f + \bar{a} - c)} df \right].$$

The second factor is always positive and the first one is positive if the integral it contains is less than one.

$$\begin{aligned} \int_{f_{min}}^{f_{max}} \frac{\alpha}{2(1-\alpha)(f + \bar{a} - c)} df &= \frac{\alpha}{2(1-\alpha)} \int_{f_{min}}^{f_{max}} (f + \bar{a} - c)^{-1} df \\ &= \frac{\alpha}{2(1-\alpha)} \ln \left( \frac{f_{max} + \bar{a} - c}{f_{min} + \bar{a} - c} \right) \\ &= \frac{\alpha}{2(1-\alpha)} \ln \left( \frac{2-\alpha}{\alpha} \right) < 1, \end{aligned}$$

which is equivalent to

$$\ln \left( \frac{2-\alpha}{\alpha} \right) < \frac{2(1-\alpha)}{\alpha}.$$

The left- and right-hand side of the above inequality are decreasing in  $\alpha$  and are identical for  $\alpha = 1$ . But since the derivative of the left-hand side with respect to  $\alpha$ ,  $\frac{-2}{\alpha(2-\alpha)}$ , is larger than the derivative of the right-hand side with respect to  $\alpha$ ,  $\frac{-2}{\alpha^2}$ , the above inequality holds for all  $\alpha \in (0, 1)$ . This proves that  $f_{max}$  increases in  $\alpha$  everywhere, and hence that expected profits  $\frac{\alpha}{\Gamma}(f_{max} - c)$  are increasing in  $\alpha$ . We conclude that the expected consumer payment is increasing in  $\alpha$ .  $\square$

**Proof of Proposition 5.** First, we show that (almost) all consumers who buy at some (equilibrium or out-of-equilibrium) headline price  $f_i$  must study with probability one. Towards a contradiction, suppose firm  $i$  attracts some browsing consumers with a given positive probability conditional on setting  $f_i$  (and all firms  $j \neq i$  follow their equilibrium pricing strategy). Firm  $i$  can therefore earn arbitrarily large profits by charging  $f_i$  and increasing  $a_i$  to the desired (expected) profit level and drawing  $\gamma_i$  randomly from the uniform distribution, since in that case with probability one consumers only avoid paying  $a_i$  if they study, a contradiction. We conclude that (almost) all consumers who buy study with probability one at any given (equilibrium or out-of-equilibrium) headline price  $f_i$ .

We next show that for any equilibrium headline price  $f_i < v_H$  at which some high-value consumers study,  $a_i \geq v_H - f_i$ . If  $a_i < v_H - f_i$  firm  $i$  could increase the additional price slightly in which case all high-value consumers still have a strict incentive to buy, and thereby increase its profits—a contradiction. We now show that for any equilibrium headline price  $f_i < v_H$  and  $f_i \neq v_L$  at which some high value consumers study,  $a_i = v_H - f_i$ . If  $a_i > v_H - f_i$  almost all studying high-value consumers do not purchase. In case  $a_i > v_H - f_i$ , the firm could raise its profits by

charging an additional price  $a_i = v_H - f_i - \epsilon_1$  for some small enough  $\epsilon_1 > 0$ ; in this case studying low-value consumers behavior is unaltered and almost all studying high-value consumers purchase and pay  $v_H - \epsilon_1 > c$ , increasing the firms profit—a contradiction. We conclude that  $f_i + a_i = v_H$  in equilibrium whenever  $f_i < v_H$  and  $f_i \neq v_L$ .

Furthermore, our second equilibrium selection assumption implies that for any equilibrium  $f_i \leq v_L$  at which no high-value consumers study or any out-of-equilibrium headline price  $f_i$ , the expected additional price  $E[a_i|f_i] \geq v_H - f_i$ . This follows from the fact that studying low-value consumers do not pay the additional price, and hence consumers must believe  $a_i$  to be chosen to target another group: either studying high-value consumers (in which case  $a_i = v_H - f_i$ ) or browsing consumers that purchase in which case  $a_i$  is chosen arbitrarily high. Furthermore, the choice of  $\gamma_i$  is irrelevant for the profits earned from high-value consumers, and hence can only affect the profits from browsing low-value consumers who make an (out-of-equilibrium) purchase; hence when targeting this group, it is profit-maximizing to not have a mass point in the distribution of  $\gamma_i$  so that these consumers cannot avoid the additional price with positive probability.

Given that for all (equilibrium and out-of equilibrium)  $f_i < v_L$ , consumers believe that  $E[a_i|f_i] \geq v_H - f_i$  and that they incur it with probability one when purchasing without studying, the expected payoff of browsing is non-positive. This implies that (a) for all  $f_i < v_L$ , low-value consumers must study and buy with probability one. Furthermore, (b) high-value consumers are indifferent between studying and browsing (and not purchasing) for any  $f_i < v_L$ .

Furthermore, since a given fraction  $\epsilon \in (0, 1]$  of high-value consumers browse when indifferent, then—since for any equilibrium headline price  $f_i$  high-value consumers are indifferent between studying and browsing—a fraction  $1 - \epsilon$  of high-value consumers study for any  $f_i < v_L$ . We will now argue that in any equilibrium firms must set  $f_i = v_L$ . Suppose not. If  $f_i < v_L$  firm  $i$  could deviate and set a price  $f'_i = f_i + (v_L - f_i)/2$  for which studying low-value consumers still have a strict incentive to buy. Because the payoff from browsing is zero, at least the fraction  $1 - \epsilon$  of high-value consumers must study at  $f'_i$ . Firm  $i$  could then set an additional price  $a_i = v_H - f'_i - \epsilon_2$ , which for sufficiently small  $\epsilon_2 > 0$  induces all studying high-value consumers to buy. Because this deviation raises the profits earned from low-value consumers by some given strictly positive amount, it is a profitable deviation for sufficiently small  $\epsilon_2$ . We conclude that in any equilibrium,  $f_i \geq v_L$ .

We next show that in any equilibrium  $f_i \leq v_L$ . Consider a firm that charges  $f_i = v_L - \epsilon_3$  and  $a_i = v_H - v_L$  for some  $\epsilon_3 > 0$ . This firm earns  $v_L - \epsilon_3$  from low-value consumers and  $v_H - \epsilon_3$  from the fraction  $1 - \epsilon$  of high-value consumers that study; i.e. it earns  $\alpha v_L + (1 - \alpha)(1 - \epsilon)v_H - \epsilon_3$ . For small enough  $\epsilon_3$ , this is strictly greater than the maximal profits a firm can earn from high-value consumers, which is  $(1 - \alpha)(1 - \epsilon)v_H$ . And because low-value consumers do not purchase for  $f_i > v_L$ , this implies that  $f_i \leq v_L$ . Together with the previous paragraph, we can thus conclude that  $f_i = v_L$ .

We now show that the firm sets  $a_i = v_H - v_L$  as long as some high-value consumers buy (and hence the fraction of high-value consumers  $\epsilon$  that browse when indifferent is less than one). We already ruled out that  $a_i < v_H - v_L$  when some high-value consumers study. In case,  $a_i > v_H - v_L$  and some high-value consumers study when indifferent, the firm can deviate by setting  $a_i = v_H - v_L$  and  $f_i = v_L - \epsilon_4$  for some  $\epsilon_4 > 0$ . In this case all low-value consumers study and buy from firm  $i$ , and the fraction  $1 - \epsilon$  of high-value consumers that study now also buy from firm  $i$ , which for

sufficiently small  $\epsilon_4$  increases profits. Hence, in any equilibrium consumers who purchase pay their valuation.

We are left to show that there exists an equilibrium in which  $f_i = v_L$  and  $a_i = v_H - v_L$  and a fraction  $\epsilon$  of high-value consumers browse. We specify equilibrium strategies as follows: Low-value consumers study for all  $f_i$ , and purchase if and only if  $f_i \leq v_L$ . A given share  $\epsilon$  of high-value consumers browse for all  $f_i$ , and refrain from purchasing when doing so. The remaining high-value consumers study for all  $f_i$ , and purchase if and only if  $f_i + a_i \leq v_H$ . Firms set prices  $f_i = v_L$  and  $a_i = v_H - v_L$  and draw  $\gamma_i$  from a uniform distribution over conditions  $[0, 1]$ . For any  $f_i \leq v_H$ , consumers believe that  $a_i = v_H - f_i$  and that  $\gamma_i$  is drawn from the uniform distribution over  $[0, 1]$ ; for  $f_i > v_H$  consumers believe that  $a_i = 0$ . It is straightforward to verify that the firms strategies are a best response, and that the consumers search and purchase decisions are sequentially rational and consistent.  $\square$

**Proof of Proposition 6.** We construct an equilibrium as follows. Firms always charge  $f_i = c - (1 - \alpha)\bar{a}$ ,  $a_i = \bar{a}$ , and randomize  $\gamma_i$  uniformly on the unit interval. For any headline price(s), consumers believe that  $a_i = \bar{a}$  and  $\gamma_i$  is chosen uniformly. For any headline price, both consumer types always browse. It suffices to specify consumer strategies for headline prices in which at most one firm deviated. For these histories, consumers choose a cheaper headline price, and if they are equal, the consumer buys from the firm she was initially assigned to. Low-value consumers choose conditions  $\gamma_d$ , and  $\tilde{\gamma} = 0$ . High-value consumers choose the usage pattern that is costless for them. It is obvious that this constitutes an equilibrium.  $\square$

**Auxiliary results for the proof of Proposition 7.** To find the firms' optimal pricing strategies, we determine the probability with which a given headline price is among the  $K$ -highest ones. To do so, we use the fact that one can rewrite the binomial distribution as a beta distribution, which we establish first. Denote the cumulative distribution function of a binomial distribution by

$$B_n(k) = \sum_{i=0}^k \binom{n}{i} p^i (1-p)^{n-i},$$

i.e. the probability to have  $k \in \{0, 1, \dots, n\}$  or less successes out of  $n$  draws when each draw has a success probability of  $p$ . Denote the corresponding probability density function by

$$b_n(k) = \binom{n}{k} p^k (1-p)^{n-k}.$$

Now define

$$H_n(k) = \frac{n!}{(n-k-1)!k!} \int_0^{1-p} x^{n-k-1} (1-x)^k dx \text{ for } k \in \{0, 1, \dots, n\}.$$

This is the beta distribution with left parameter  $n - k$ , right parameter  $k + 1$ , evaluated at  $1 - p$ .

**Lemma 5.**  $B_n(k) = H_n(k)$ .

*Proof.* At  $k = 0$ , we have  $H_n(0) = B_n(0) = b_n(0) = (1 - p)^n$ . For  $k \in \{1, 2, \dots, n\}$  integrating  $H_n(k)$  by parts with  $v = (1 - x)^k$  and  $du = x^{n-k-1}dx$  leads to

$$H_n(k) = \binom{n}{k} p^k (1 - p)^{n-k} + \frac{n!}{(n-k)!(k-1)!} \int_0^{1-p} x^{n-k} (1-x)^{k-1} dx = b_n(k) + H_n(k-1).$$

It follows that  $H_n(k) = \sum_{i=0}^k b_n(i) = B_n(k)$  for  $k \in \{0, 1, \dots, n\}$ . □

**Proof of Proposition 7.** We establish that there exists a symmetric equilibrium in which firms' headline prices are drawn from a continuous distribution with support  $[f_{min}, f_{max}]$  and the additional price is set to  $\bar{a}$  with probability one. We begin by solving a class of auxiliary games in which consumers' search behavior is fixed. We then show that the specified consumer search behavior is an optimal response to the firms' pricing strategies for exactly one game in this class, which together gives rise to an equilibrium in the original game. Thereafter, we derive comparative statics.

For simplicity, we specify the consumer search strategy only for events in which at most one firm deviated and chose a headline price that is not in the support  $[f_{min}, f_{max}]$ , and we implicitly suppose this is the case below.<sup>34</sup> When observing headline prices weakly below  $f_{max}$  in all markets, low-income consumers study in  $K$  markets, where the probability that a given market is studied is identical for all markets; when observing one price above  $f_{max}$ , low-income consumers browse in the respective market and study  $K - 1$  other markets, where each of the remaining markets is studied with equal probability. High-income consumers incur the additional price in all markets, and they browse headline prices in the  $K$  most expensive markets. We refer to  $f_{max}$  as low-income consumers' browsing threshold.

*Step 1: equilibrium of the auxiliary game with a given browsing threshold  $f_{max}$ .* Given that high-income consumers browse, the symmetric equilibrium pricing strategy cannot have a mass point by standard arguments. Thus, using the binomial distribution, if firms play a symmetric headline-price strategy with cumulative distribution function  $F$ , the probability that  $K$  out of  $N - 1$  headline price draws are greater than a headline price  $f$  is

$$Pr(K \text{ of } N - 1 \text{ prices larger } f) = \binom{N-1}{K} (1 - G(f))^K G(f)^{N-1-K}.$$

The probability that  $K$  draws are greater than  $f$ , and  $N - 1 - K$  draws smaller than  $f$  is  $(1 - G(f))^K G(f)^{N-1-K}$ . There are  $\binom{N-1}{K}$  combinations to draw  $K$  firms out of  $N - 1$ .

To characterize demand from browsing high-income consumers, we distinguish three sources of demand. First, consumers initially assigned to firm  $j$  who browse only in other markets. Second, consumers initially assigned to firm  $j$  who browse in the firm's market. Third, consumers initially assigned to firm  $j$ 's competitor who browse and then purchase from firm  $j$ .

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<sup>34</sup> Other histories are irrelevant for the equilibrium incentives and hence need not be specified; see Blume and Heidhues (2006).

With probability  $1/2$ , a high-income consumer is initially assigned to firm  $j$  in its market. A high-income consumer initially assigned to firm  $j$  does not browse its competitor if she observes  $K$  or more larger prices in the other  $N - 1$  markets. Hence, the probability that a high-income consumer is initially assigned to firm  $j$  and does not browse in  $j$ 's market is

$$\frac{1}{2} \underbrace{\sum_{i=K}^{N-1} \binom{N-1}{i} (1 - G(f_j))^i G(f_j)^{N-1-i}}_{\text{At least } K \text{ draws above } f_j} = \frac{1}{2} \left[ 1 - \sum_{i=0}^{K-1} \binom{N-1}{i} (1 - G(f_j))^i G(f_j)^{N-1-i} \right].$$

Whenever a high-income consumer initially assigned to firm  $j$  observes strictly less than  $K$  initial draws above  $f_j$ , she browses the firm's competitor. In that case she buys from firm  $j$  if it is cheaper, which happens with probability  $(1 - G(f_j))$ . Hence, the probability that a high-income consumer is assigned to firm  $j$ , browses its competitor, and ends up buying from firm  $j$  is

$$\frac{1}{2} \underbrace{\sum_{i=0}^{K-1} \binom{N-1}{i} (1 - G(f_j))^i G(f_j)^{N-1-i}}_{\text{Less than } K \text{ draws above } f_j} \cdot (1 - G(f_j)).$$

Finally, high-income consumers initially assigned to the competitor buy from firm  $j$  if both firm  $j$  has a lower price, which happens with probability  $(1 - G(f_j))$ , and if conditional on charging a price above  $f_j$ , the competitor's headline price is among the  $K$ -highest ones observed by its consumers. Thus, the probability that high-income consumers are initially assigned to the competitor, browse, and buy from firm  $j$  is

$$\frac{1}{2} \underbrace{\int_{f_j}^{f_j^{max}} \sum_{i=0}^{K-1} \binom{N-1}{i} (1 - G(z))^i G(z)^{N-1-i} \frac{g(z)}{(1 - G(f_j))} dz}_{\text{Competitor's customers browse given that the competitor charges a price above } f_j} \cdot (1 - G(f_j)).$$

Here the integrand corresponds to the first term in the previous expression, but we now have to take expectations about the competitor's headline price, giving rise to the integral.

Hence, firm  $j$ 's overall demand from high-income consumers is

$$D(f_j) = \frac{1}{2} \left[ 1 - \sum_{i=0}^{K-1} \binom{N-1}{i} (1 - G(f_j))^i G(f_j)^{N-1-i} \cdot G(f_j) + \int_{f_j}^{f_j^{max}} \sum_{i=0}^{K-1} \binom{N-1}{i} (1 - G(z))^i G(z)^{N-1-i} g(z) dz \right].$$

Using Lemma 5 to rewrite cumulative distribution function of the binomial distribution for success probability  $p = 1 - G(f_j)$  as a beta distribution with left parameter  $N - 1 - K$  and right parameter  $K$  evaluated at  $G(f_j)$  yields

$$\sum_{i=0}^{K-1} \binom{N-1}{i} (1 - G(f_j))^i G(f_j)^{N-1-i} = \frac{(N-1)!}{(N-1-K)!(K-1)!} \int_0^{G(f_j)} x^{N-K-1} (1-x)^{K-1} dx. \quad (7)$$

Hence,

$$\begin{aligned}
& D(f_j) \\
&= \frac{1}{2} \left[ 1 - \frac{(N-1)!}{(N-1-K)!(K-1)!} \left[ \int_0^{G(f_j)} x^{N-K-1}(1-x)^{K-1} dx \cdot G(f_j) - \int_{f_j}^{f_{max}} g(z) \int_0^{G(z)} x^{N-K-1}(1-x)^{K-1} dx dz \right] \right] \\
&= \frac{1}{2} \left[ 1 - \frac{(N-1)!}{(N-1-K)!(K-1)!} \left[ \int_0^{G(f_j)} x^{N-K-1}(1-x)^{K-1} dx \cdot G(f_j) - \left[ G(z) \int_0^{G(z)} x^{N-K-1}(1-x)^{K-1} dx \right]_{f_j}^{f_{max}} \right. \right. \\
&+ \left. \left. \int_{f_j}^{f_{max}} G(z)^{N-K}(1-G(z))^{K-1} g(z) dz \right] \right] \\
&= \frac{1}{2} \left[ 2 - \frac{(N-1)!}{(N-1-K)!(K-1)!} \left[ 2 \int_0^{G(f_j)} x^{N-K-1}(1-x)^{K-1} dx \cdot G(f_j) + \int_{G(f_j)}^1 x^{N-K}(1-x)^{K-1} dx \right] \right]. \tag{8}
\end{aligned}$$

The first equality follows from Lemma 5. The second equality follows from integration by parts on the outer integral of the last term. To derive the third equality, we use that (7) evaluated at  $G(f_{max}) = 1$  implies

$$\int_0^1 x^{N-K-1}(1-x)^{K-1} dx \cdot \frac{(N-1)!}{(N-1-K)!(K-1)!} = 1,$$

and do the change of variable  $x = G(z)$  in the last integral.

Note that this demand  $D(f_j)$  depends only on  $G(f_j)$ ,  $N$ , and  $K$ . Since  $G(\cdot)$  is weakly increasing and continuous, it is almost everywhere differentiable. Furthermore, it is decreasing in  $f_j$  whenever the density is strictly positive:

$$D'(f_j) = \frac{-g(f_j) \cdot (N-1)!}{2(N-1-K)!(K-1)!} \left[ G(f_j)^{N-K}(1-G(f_j))^{K-1} + 2 \int_0^{G(f_j)} x^{N-K-1}(1-x)^{K-1} dx \right]. \tag{9}$$

Using that low-income consumer study in  $K/N$  randomly chosen markets and the demand from high-income consumers, firm  $j$ 's profits when setting a price below  $f_{max}$  are

$$\pi(f_j) = \frac{\alpha}{2} \left( f_j + \left( 1 - \frac{K}{N} \right) \bar{a} - c \right) + (1-\alpha)D(f_j)(f_j + \bar{a} - c).$$

Since  $D(f_{max}) = 0$ ,

$$\pi(f_{max}) = \frac{\alpha}{2} \left( f_{max} + \left( 1 - \frac{K}{N} \right) \bar{a} - c \right).$$

To be indifferent between all prices  $f_j \in [f_{min}, f_{max}]$ , equilibrium requires that

$$\pi(f_j) = \pi(f_{max}), \quad \forall f_j \in [f_{min}, f_{max}], \quad (10)$$

which implies that

$$D(f_j) = \frac{\alpha}{2(1-\alpha)} \cdot \frac{f_{max} - f_j}{f_j + \bar{a} - c}, \quad \forall f_j \in (f_{min}, f_{max}). \quad (11)$$

We now construct the headline price distribution  $G(\cdot)$  on  $f_j \in (f_{min}, f_{max})$  that satisfies (11). Differentiating (11) yields

$$D'(f_j) = -\frac{\alpha}{2(1-\alpha)} \cdot \frac{f_{max} + \bar{a} - c}{(f_j + \bar{a} - c)^2}.$$

Substituting the expression from (9) and rearranging, gives

$$g(f_j) = \quad (12)$$

$$\frac{(N-1-K)!(K-1)!}{(N-1)!} \left[ G(f_j)^{N-K} (1-G(f_j))^{K-1} + 2 \int_0^{G(f_j)} x^{N-K-1} (1-x)^{K-1} dx \right]^{-1} \left[ \frac{\alpha}{(1-\alpha)} \cdot \frac{f_{max} + \bar{a} - c}{(f_j + \bar{a} - c)^2} \right]. \quad (13)$$

The right-hand side is continuous and strictly positive on the interval  $(f_{min}, f_{max})$ . Since additionally (11) is satisfied at  $G(f_{max}) = 1$ , integrating the above gives rise to a unique candidate symmetric equilibrium headline price distribution in the auxiliary game. Furthermore, obviously no firm can benefit from deviating and reducing the additional price or charging a headline price above  $f_{max}$ —yielding zero demand—or charging one below  $f_{min}$ —which does not increase demand relative to charging  $f_{min}$ . Finally, since browsing high-income consumers purchase for all headline prices below  $f_{max}$ , it is optimal to set the maximal additional price  $a_j = \bar{a}$ . We conclude that a unique symmetric equilibrium exists in the auxiliary game for every search threshold  $f_{max}$ .

*Step 2: Optimal search strategies of consumers pin down a unique  $f_{max}$ .* High-income consumers' search strategy is an optimal response to the firms' pricing strategies in all auxiliary games above, which differ in the low-income consumers search threshold  $f_{max}$ . High-income consumers never avoid  $\bar{a}$  when studying. Since  $G(\cdot)$  is continuous, i.e. has no mass point, high-income consumers strictly prefer browsing to studying for all prices above  $f_{min}$ , and are indifferent otherwise.

We now pin down the search threshold  $f_{max}$  for which low-income consumers' search strategies are an optimal response to the firms' pricing strategies. In equilibrium, the optimal threshold of low-income consumers must satisfy  $f_{max} = E(f_j) + \bar{a}$ , which implies that low-income consumers who observe the largest possible price  $f_{max}$  are indifferent between studying and browsing. Thus,



for all  $f_j < f_{max}$  low-income consumers strictly prefer to study. If  $f_{max} > E(f_j) + \bar{a}$ , low-income consumer strictly prefer browsing at prices close to  $f_{max}$ , which is inconsistent with equilibrium. If  $f_{max} < E(f_j) + \bar{a}$ , low-income consumers strictly prefer to study for off-equilibrium prices  $f_j \in (f_{max}, E(f_j) + \bar{a})$ . Thus, firms could increase profits by charging prices above  $f_{max}$  where low-income consumers would still study. Thus, the only  $f_{max}$  consistent with consumer search strategies in the previous auxiliary game satisfies  $f_{max} = E(f_j) + \bar{a}$ .

We show that there exists a unique search threshold  $f_{max}$  for which  $f_{max} - E(f_j) = \bar{a}$ . Because no firm sets prices below costs, as  $f_{max} \rightarrow c$  one has  $f_{max} - E(f_j) \rightarrow 0 < \bar{a}$ . To prove existence and uniqueness, we establish that  $f_{max} - E(f_j)$  is strictly increasing and unbounded.

We observe first that  $E(f_j)$  increases in  $f_{max}$ . For all prices in the support of the equilibrium headline price distribution, the fact that firms need to be indifferent between setting  $f_j$  and  $f_{max}$ , i.e. (11), implies that  $D(f_j)$  is strictly increasing in  $f_{max}$ . By (8), the fact that  $D(f_j)$  is strictly increasing in  $f_{max}$  implies that  $G(f_j)$  is strictly decreasing in  $f_{max}$ , so that the headline price distribution for a higher  $f_{max}$  first-order stochastically dominates that for a lower one. Consequently,  $E(f_j)$  increases in  $f_{max}$ .

We show next that  $f_{max} - E(f_j)$  is strictly increasing. Fix an interval  $s = f_{max} - f_j$ , where  $s \leq f_{max} - f_{min}$ . The equilibrium condition (11) implies that  $D(f_j = f_{max} - s)$  is strictly decreasing in  $f_{max}$  for any given headline price difference  $s$ . By (8), the fact that  $D(f_j = f_{max} - s)$  is strictly decreasing implies that  $G(f_j = f_{max} - s)$  is strictly increasing in  $f_{max}$  for any given  $s \in (0, f_{max} - f_{min})$ . Thus,  $f_{max} - E(f_j)$  is strictly increasing.

Finally, we establish that  $f_{max} - E(f_j)$  increases unboundedly. To do so, we prove that for any constant  $s > 0$  the probability mass in  $(f_{max} - s, f_{max})$  goes to zero as  $f_{max} \rightarrow \infty$ , implying that for sufficiently large  $f_{max}$ ,  $f_{max} - E(f_j) > s$ . Note first that (10) applied at  $f_{min}$  implies  $f_{min} + \bar{a} - c = \frac{\alpha}{2-\alpha}(f_{max} + \bar{a} - c)$ , and therefore  $\lim_{f_{max} \rightarrow \infty} (f_{max} - f_{min}) = \infty$ . Thus, for any  $s > 0$  and a sufficiently large  $f_{max}$ ,  $f_j = f_{max} - s \in (f_{min}, f_{max})$ . Using (12), we establish now that  $\lim_{f_{max} \rightarrow \infty} g(f_j = f_{max} - s) = 0$  for any  $s > 0$ . Since  $G(f_j = f_{max} - s)$  is strictly increasing in  $f_{max}$ ,

$$\int_0^{G(f_j)} x^{N-K-1}(1-x)^{K-1} dx$$

has a strictly positive limit as  $f_{max} \rightarrow \infty$ , and hence the first term in squared brackets of (12) has strictly positive limit as  $f_{max} \rightarrow \infty$ . For any given  $s > 0$ , the second term in squared brackets of (12) goes to zero as  $f_{max} \rightarrow \infty$ . Together this implies that  $\lim_{f_{max} \rightarrow \infty} g(f_j = f_{max} - s) = 0$  for any  $s > 0$ . We conclude that for any constant  $s > 0$ , the probability mass in  $(f_{max} - s, f_{max})$  goes to zero as  $f_{max} \rightarrow \infty$ , implying that for any  $s > 0$  and sufficiently large  $f_{max}$ ,  $f_{max} - E(f_j) > s$ .

*Step 3: Comparative Statics.* Let  $\Gamma \equiv f_{max} - E(f_j) - \bar{a} = 0$ . Note that

$$E(f_j) = f_{min} + \int_{f_{min}}^{f_{max}} (1 - G(f_j)) df.$$

Since (11) is continuous in  $G(f_j), c, \bar{a}, \alpha, f_{min}$ , and  $f_{max}$ , and since  $\Gamma$  is continuous in  $f_{max}, f_{min}, \bar{a}$ , and  $G(f_j)$ , the derivative of  $f_{max}, f_{min}$ , and  $G(f_j)$  with respect to any of these variables exists.

Consequently, for any parameter  $x$  that influences  $G(\cdot)$ , one has  $\frac{\partial E(f_j)}{\partial x} = - \int_{f_{min}}^{f_{max}} \frac{\partial G(f_j)}{\partial x} df$ . Thus, if  $G(f_j)$  decreases (increases) in  $x$  for all  $f_j$ , the expected value increases (decreases) in  $x$ .

Using the implicit-function theorem on  $\Gamma$ , we see that

$$\frac{\partial f_{max}}{\partial \alpha} = - \left[ \frac{\partial \Gamma}{\partial f_{max}} \right]^{-1} \left[ \frac{\partial \Gamma}{\partial \alpha} \right] = \left[ 1 - \frac{\partial E(f)}{\partial f_{max}} \right]^{-1} \left[ \frac{\partial E(f)}{\partial \alpha} \right] > 0.$$

We have shown above that  $E(f_j)$  and  $f_{max} - E(f_j)$  are increasing in  $f_{max}$ , so that  $\partial E(f_j)/\partial f_{max} \in (0, 1)$ , and since  $G(f_j)$  decreases in  $\alpha$  for all  $f_j$ , we know that  $\partial E(f_j)/\partial \alpha > 0$ , and therefore  $\frac{\partial f_{max}}{\partial \alpha} > 0$ . Consequently, profits and expected payments increase in the share of low-income consumers.

Similarly, we obtain that  $\frac{\partial E(f_j)}{\partial c} > 0$  and  $\frac{\partial E(f_j)}{\partial \bar{a}} < 0$ .  $\square$

**Proof of Proposition 8.** *Part 1: If  $J \leq N - K$ , then there is an equilibrium in which the distribution of firms' prices is the same as in Proposition 7, and there is no equilibrium in which all firms charge the additional price  $\bar{a}$  along with the zero-profit headline price.* We first establish the existence of the equilibrium that mimics the headline price distribution of Proposition 7. To do so, we solve for the symmetric equilibrium price distributions supposing that (i) high-income consumers browse; (ii) if all observed headline prices are below the threshold  $f_{max}$  we characterized in the proof of Proposition 7, low-income consumers study with equal probability in  $K$  of the  $N - J$  unregulated markets and avoid the additional price in the  $J$  regulated markets without studying; if one price is above  $f_{max}$ , low-income consumers browse in the corresponding market and study in  $K - 1$  unregulated markets in which the headline price is below  $f_{max}$ , selecting each these markets with equal probability. (As before, we do not specify search behavior for the case that more than two headline prices above  $f_{max}$  are observed by a low-income consumer because this requires simultaneous deviations by two or more firms and, thus, is irrelevant for equilibrium incentives.)

Given that high-income consumers browse and pay for the additional price in all markets, it is strictly optimal for firms to charge  $a_i = \bar{a}$  when choosing a headline price below  $f_{max}$ . When charging a headline price above  $f_{max}$ , a firm makes no sales and hence such a headline price is suboptimal. In a regulated market, for any headline price below  $f_{max}$  the firm sells to all low-income consumers initially assigned to it, and—because high-income consumers browse the highest  $K$  prices across all markets—the demand from high-income consumers is the same  $D(\cdot)$  we solved for in the proof of Proposition 7. Hence, for headline prices below  $f_{max}$  profits are

$$\pi(f_j) = \frac{\alpha}{2} (f_j - c) + (1 - \alpha) D(f_j) (f_j + \bar{a} - c).$$

Rewriting the equilibrium condition that  $\pi(f_j) = \pi(f_{max})$  for all headline prices in  $(f_{min}, f_{max})$  shows that for all equilibrium headline prices

$$D(f_j) = \frac{\alpha}{2(1 - \alpha)} \cdot \frac{f_{max} - f_j}{f_j + \bar{a} - c}, \quad \forall f_j \in (f_{min}, f_{max}), \quad (14)$$

which is identical to (11) in the proof of Proposition 7. Hence, since equilibrium requires the exact same demand from browsing high-income consumers, it is solved by the same equilibrium headline price distribution  $G(\cdot)$ . Since the headline price does not affect low-income consumers' studying decisions, the exact same steps as above demonstrate that  $G(\cdot)$  is also the equilibrium headline price distribution in the unregulated markets.

To establish that  $G(\cdot)$  still gives rise to an equilibrium, we still need to verify that the consumer search behavior remains optimal. This is immediate for high-income consumers who do not want to avoid the additional price. Now consider a low-income consumer for whom the highest observed headline price is  $f_{max}$ . We argue that she is indifferent between browsing in the corresponding market and studying in an unregulated markets. This implies that she finds studying optimal if all prices are below  $f_{max}$  and browsing optimal when one headline price is above  $f_{max}$ .

When observing a maximal headline price of  $f_{max}$ , browsing in the corresponding market leads to an expected headline-price saving of  $f_{max} - E(f)$  independent of whether the market is regulated or unregulated. But in case the low-income consumer browses in this market, she can only study in  $K - 1$  unregulated markets, implying that she incurs the additional price in one extra market leading to a higher expenditure on additional prices of  $\bar{a}$ . Since for the equilibrium headline price distribution  $f_{max} - E(f) = \bar{a}$ , she is exactly indifferent between browsing and studying. We conclude that low-income consumer search behavior is optimal, and hence that we have specified a symmetric price distribution.

Next, we show that if  $J \leq N - K$ , there exists no equilibrium in which all firms charge the additional price  $\bar{a}$  along with the zero-profit headline price. Suppose otherwise. Let  $f$  denote the zero-profit headline price. Consider the case in which firm  $i$  sets a headline price  $f_i$  and all rivals set  $f$ . In case  $f_i < f + \bar{a}$ , it is strictly optimal for low-income consumers to study. Hence, when all firms set  $f$  low-income consumers study and therefore do not pay the additional price in all markets. As a result, the zero-profit headline price  $f > c - \bar{a}$ . If firm  $i$  deviates and charges a headline price  $f_i \in (c, f + \bar{a})$  it earns strictly positive profits from any consumer it attracts, and it keeps its initially assigned low-income consumers, a contradiction.

*Part 2: If  $J > N - K$ , then there is an equilibrium in which all firms charge the additional price  $\bar{a}$  along with the zero-profit headline price, and there is no equilibrium in which the distribution of firms' prices is the same as in Proposition 7.* We prove the existence of such a zero-profit equilibrium. Let  $f = c - (1 - \alpha)\bar{a}$  be zero-profit headline price. Consider the following consumer search strategy. In case a consumer observes a headline price weakly below  $f$  in all markets initially, they browse each of the  $N$  market with probability  $[K - (N - J)]/N$ , and then study in the  $N - J$  unregulated markets a lowest-price firm. In case consumers observe one headline price  $f_i > f$  and all others equal to  $f$ , both types of consumers browse in  $i$ 's market with probability one, browse in all other markets with probability  $[K - (N - J) - 1]/(N - 1)$ , and then study in the  $N - J$  unregulated markets a lowest-price firm.

Consider a firm  $i$ . Setting  $a_i = \bar{a}$  does not decrease demand and increases the revenue from consumers, strictly so for high-income consumers. Deviating to a headline price  $f_i > f$  is unprofitable as it results in zero demand, and a headline price  $f_i < f$  attracts the same proportion of high- and low-income consumers than the firm attracts in equilibrium, and hence leads to negative profits. We conclude that the firms have no incentive to deviate.

It remains to show that the consumers' search strategy is optimal. Consider low-income consumers first. Given search strategy, they avoid paying the additional price in all markets. Given all initially observed prices are weakly below  $f$ , the search strategy ensures that they avoid paying the additional price in all markets and buy at the cheapest headline price they have seen in each market. Furthermore, any additional studying or browsing does not save money as in equilibrium firms set  $f_i = f$ . If one firm sets a price above  $f$ , low-income consumers can save money by initially browsing in that market and thereafter studying in all unregulated markets a cheapest-priced firm. Furthermore, any additional browsing or studying would not save any money, which implies that their search strategy is optimal. High-income consumers cannot save any additional money from browsing or studying as long as at most one price they initially observe is above  $f$ , and hence their search strategy is optimal.

We are left to show that there is no equilibrium in which the distribution of firms' prices is the same as in Proposition 7. Suppose otherwise. Since  $f_{max} = E(f) + \bar{a}$ , low-income consumers study with probability one in all unregulated markets when observing initial headline prices below  $f_{max}$  in all markets. Furthermore, since they observe  $f_{min}$  with probability zero and all firms use the same headline price distribution, they must browse in the  $K - (N - J)$  markets in which the initial headline price is highest. When observing initial headline price above  $f_{min}$ , high-income consumers strictly prefer browsing and hence must do so. Consider  $f_i = \max\{f_{min}, c\}$ . Since  $f_{max} > c$ ,  $f_i < f_{max}$ . Because any firm setting  $f_i, \bar{a}$  attracts high-income consumers with positive probability and cannot lose money from low-income consumers, it earns strictly positive profits. Denote these profits by  $\pi$ . As  $f_i \rightarrow f_{max}$ , firm  $i$ 's probability of being the highest-price firm goes to one, and therefore its profits to zero. This contradicts that it must earn at least  $\pi$  for almost all prices in the support.  $\square$

**Proof of Proposition 9.** In the proof of Proposition 4 we derived the headline-price distribution for any value  $f_{max}$  when high-value consumers browse and low-value consumers study. Take this distribution (2) as a candidate equilibrium price distribution with  $f_{max} = \min\{v_L, E[f] + \bar{a}, E[f] + s_3\}$ . Recall that (2) has no mass point at  $f_{max}$ .

We now consider the search strategies of consumers. High-value consumers always pay the additional price. This is why they strictly prefer browsing when they observe an initial (on- or off-equilibrium) headline price  $f_i > f_{min}$ . Recall that our second equilibrium-selection assumption implies that consumers believe additional prices of off-equilibrium offers are  $\bar{a}$ . For off-equilibrium prices  $f_i \leq f_{min}$ , they weakly prefer browsing. We conclude that high-value consumers browse with probability one in the candidate equilibrium.

When low-value consumers observe an initial headline price  $f_i < f_{max}$  they strictly prefer studying. For these prices, consumers prefer to buy ( $f_i < v_L$ ), and pay a lower total price by studying than they would if they would browse instead ( $f_i < E[f] + \bar{a}$ ). Consumers could also invest the search cost  $s_3$  to learn a third price, but do not benefit from it since  $f_i < E[f] + s_3$ .

The following argument shows that the consumer does not benefit from searching a third price if  $f_i < E[f] + s_3$ . Investing  $s_3$  induces two possible deviations. The consumer could browse a second headline price and study the second offer, inducing expected costs of  $E[f] + s_3$ . Alternatively, he could browse a second headline price and study the initial offer. But the former deviation dominates the latter. To see this, note that the candidate equilibrium induces the largest incentive to invest

$s_3$  when low-value consumers observe an initial price  $f_{max}$ . Observing  $f_{max}$  initially, a browsing low-value consumer will observe a smaller headline price with probability one. But then the low-value consumer is strictly better off by studying the conditions of the second offer to avoid the additional price of this offer. Thus, the relevant deviation induces prices  $E[f] + s_3$ . We conclude that low-value consumers strictly prefer not to search a third price if their initial headline price satisfies  $f_i < E[f] + s_3$ .

It follows that low-value consumers strictly prefer to search a third price if  $f_i > E[f] + s_3$ .

Overall, we conclude that low-value consumers strictly prefer to study additional prices if  $f_i < f_{max}$ , and weakly prefer to study additional prices if  $f_i = f_{max}$ .

For off-equilibrium prices  $f_i > f_{max}$ , our second equilibrium-selection assumption implies that consumers believe additional prices are  $\bar{a}$ . Thus, if low-value consumers observe an initial headline price  $f_i > E[f] + \bar{a}$ , they prefer to browse headline prices instead, and if they observe  $f_i > E[f] + s_3$ , they prefer to invest  $s_3$  to browse and study a second product. Thus, low-value consumers browse a second product if they observe a price  $f_i > f_{max}$ .

It follows that there exists an equilibrium where firms set headline prices according to (2) and set  $f_{max} = \min\{v_L, E[f] + \bar{a}, E[f] + s_3\}$ . If a firm  $i$  sets a price  $f_i > f_{max}$ , it will earn zero profits due to the search strategy of low-value consumers.

Since in this equilibrium  $f_{max} \leq E[f] + s_3$  and since  $s_n > s_3$ , for all  $n > 3$ , consumers do not benefit from searching more than 3 prices.

It follows that if  $s_3 \geq \bar{a}$ , the candidate equilibrium from Proposition 4 is an equilibrium.

If  $s_3 < \bar{a}$ , the most beneficial deviation for low-value consumers from studying the initial offer is no longer to browse instead, but to browse and study a second offer. Thus, if  $f_{max} = v_L < E[f|f_{max} = v_L] + s_3$ , we have  $f_{max} = v_L$ . The exact same arguments as in Step (iii) of the proof of Proposition 4 show that this is the case for any  $s_3 > 0$  when  $\alpha \rightarrow 1$ . Similarly, if  $E[f] + s_3 < v_L$ , low-value consumers who see an initial headline price above  $E[f] + s_3$  would prefer to browse and study a second offer rather than study the initial one, implying that  $f_{max} \leq E[f] + s_3$ . Since for  $f_{max} < E[f] + s_3$  firms could increase profits by raising  $f_{max}$ , we must have  $f_{max} = E[f] + s_3$ . This equation induces the same comparative statics w.r.t.  $\alpha$  as  $f_{max} = E[f] + \bar{a}$ , implying that expected prices that consumers pay increase in  $\alpha$  also when  $s_3 < \bar{a}$ .  $\square$

**Proof of Proposition 10.** We look for an equilibrium of the same type as in Proposition 4 in which low-value consumers study, high-value consumers browse, and firms charge the maximal additional prices  $\bar{a}_L$  and  $\bar{a}_H$ , and randomize over headline prices according to a common distribution  $G(f)$  with support  $[f_{min}, f_{max}]$ , where  $f_{max} \leq E(f) + \bar{a}_L$  and  $f_{max} \leq v_L$ .

Because  $f_{max} \leq E(f) + \bar{a}_L$  and  $f_{max} \leq v_L$ , it is optimal for low-value consumer to study and then buy for all equilibrium headline prices. Since for high-value consumers the costs of satisfying almost any condition is greater than  $\bar{a}_H$ , and since headline prices  $f_i$  satisfy  $f_i \leq v_L \leq v_L + \bar{a} \leq v_H$  for all firms, high-value consumers strictly prefer browsing over studying. Thus, in equilibrium high-value consumers browse offers and low-value consumers study offers to avoid paying  $\bar{a}_L$ .

Given the consumers search behavior, firms cannot increase profits by reducing  $\bar{a}_H$  or  $\bar{a}_L$ . A lower additional price for high-value consumers strictly decreases profits from these consumers without affecting demand since high-value browsing consumers do not observe the additional price.

Since low-value consumers study and avoid  $\bar{a}_L$ , changing  $\bar{a}_L$  does not affect profits, and hence the firms' additional prices are chosen optimally.

We now show that if  $\bar{a}_H$  gets smaller, average profits increase. The construction of the equilibrium headline price distribution parallels that in the proof of Proposition 4, and we therefore only sketch it here. With the different notation, the minimum headline price and the distribution of headline prices become

$$f_{min} = \frac{\alpha(f_{max} + \bar{a}_H - c)}{2 - \alpha} + c - \bar{a}_H,$$

and

$$G(f) = 1 - \frac{\alpha(f_{max} - f)}{2(1 - \alpha)(f + \bar{a}_H - c)} \quad \text{for } f \in [f_{min}, f_{max}], \quad (15)$$

respectively. Since only high-value consumers browse, it is only their headline price that appears in  $f_{min}$  and  $G(\cdot)$ .

We first consider the case where  $f_{max} < v_L$ . In this case,  $f_{max}$  is pinned down by  $f_{max} = E(f) + \bar{a}_L$ . When drawing the largest headline price, low-value consumers are indifferent between studying and browsing, which would induce them to pay an average total price of  $E(f) + \bar{a}_L$ .

Since industry profits are  $\alpha(f_{max} - c)$ , we can show that average profits decrease in  $\bar{a}_H$  by showing that  $f_{max}$  decreases in  $\bar{a}_H$ . Using again that  $E(f) = f_{min} + \int_{f_{min}}^{f_{max}} 1 - G(f)df$ , and applying the implicit-function theorem on  $f_{max} - E(f) - \bar{a}_L = 0$ , we get

$$\frac{\partial f_{max}}{\partial \bar{a}_H} = - \left[ 1 - \int_{f_{min}}^{f_{max}} \frac{\alpha}{2(1 - \alpha)(f + \bar{a}_H - c)} df \right]^{-1} \cdot \left[ \int_{f_{min}}^{f_{max}} \frac{\alpha(f_{max} - f)}{2(1 - \alpha)(f + \bar{a}_H - c)^2} df \right].$$

We know from the proof of Proposition 4 that the first term in squared brackets is always positive. To see that the second term is positive we simplify it

$$\begin{aligned} \int_{f_{min}}^{f_{max}} \frac{\alpha(f_{max} - f)}{2(1 - \alpha)(f + \bar{a}_H - c)^2} df &= \frac{\alpha}{2(1 - \alpha)} \cdot \left[ - \left[ \frac{f_{max} - f}{(f + \bar{a}_H - c)} \right]_{f_{min}}^{f_{max}} - \int_{f_{min}}^{f_{max}} (f + \bar{a}_H - c)^{-1} df \right] \\ &= 1 - \frac{\alpha}{2(1 - \alpha)} \ln \left( \frac{f_{max} + \bar{a}_H - c}{f_{min} + \bar{a}_H - c} \right) \\ &= 1 - \frac{\alpha}{2(1 - \alpha)} \ln \left( \frac{2 - \alpha}{\alpha} \right) > 0. \end{aligned}$$

In the first line, we use integration by parts. We simplify in the second line and in the third use the equilibrium level of  $f_{min}$ . We know from *Step (iv)* of Proposition 4 that the last expression is positive.

We therefore know that  $f_{max}$  decreases in  $\bar{a}_H$ . And since  $f_{max} = v_L$  whenever  $f_{max} < E(f) + \bar{a}_L$ , we conclude that average profits and prices decrease in  $\bar{a}_H$ .

To see that  $f_{max}$  increases in  $\bar{a}_L$ , recall that whenever  $f_{max} < v_L$ ,  $f_{max}$  is determined by  $f_{max} - E(f) = \bar{a}_L$ . Since by previous arguments we know that

$$\frac{\partial [f_{max} - E(f)]}{\partial f_{max}} = 1 - \int_{f_{min}}^{f_{max}} \frac{\alpha}{2(1 - \alpha)(f + \bar{a}_H - c)} df > 0,$$

and since  $[f_{max} - E(f)]$  does not depend on  $\bar{a}_L$ , we know that a larger  $\bar{a}_L$  increases  $f_{max}$ . We conclude that  $f_{max}$ , and hence profits, increases in  $\bar{a}_L$ .  $\square$

**Proof of Proposition 11.** It follows from Lemmas 3 and 4 that firms 1 and 2 play symmetric strategies in equilibrium, and that high-value consumers browse while low-value consumers study with probability one. Furthermore, the symmetric equilibrium headline price distribution of firms 1 and 2 has no mass point. Let  $f_{max}$  and  $f_{min}$  be the supremum and infimum of the incumbent firms' headline price distribution.

We proceed in four steps. First, we pin down equilibrium profits and price distributions. Second, we continue by showing that  $f_{max} \leq \min\{(1/2)E(f) + (1/2)E_3(f_3) + \bar{a}, v_L\}$ . Third, we establish that if  $f_{max} < v_L$ , then  $f_{max}$  is strictly increasing in  $\alpha$ . Fourth, we show that there exists a unique  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  if and only if  $\alpha \geq \alpha^*$ .

*Step (i): Equilibrium profits and price distributions.* We show first that firm 3 has no mass point on its support. Suppose otherwise that firm 3 has a mass point at some price  $\tilde{f}_3$ . Then firms 1 and 2 must set headline prices in an interval  $(\tilde{f}_3, \tilde{f}_3 + \eta)$  for *some*  $\eta > 0$ , since otherwise firm 3 would earn zero profits at the mass point, contradicting Lemma 2. Additionally the incumbents must set headline prices in an interval  $(\tilde{f}_3, \tilde{f}_3 + \eta)$  for *any*  $\eta > 0$ , since otherwise firm 3 could increase profits by shifting probability mass from  $\tilde{f}_3$  to a marginally larger headline price. But then an incumbent can increase demand by shifting probability mass from  $(\tilde{f}_3, \tilde{f}_3 + \eta)$  to  $\tilde{f}_3 - \eta/2$  for any  $\eta > 0$ . This does not affect demand from studying low-value consumers, but discretely increases demand from browsing high-value consumers who would otherwise switch to firm 3 more often. Since for a sufficiently small  $\eta$ , the loss in margins is negligible, this deviation strictly increases profits, contradicting that firm 3 has a mass point on its support. We conclude that firm 3 has no mass point on its support.

We continue by showing that  $G_1(\cdot)$  and  $G_2(\cdot)$  have a connected support. Suppose otherwise that there exists an interval  $(\check{f}, \hat{f}) \subset (f_{min}, f_{max})$  such that  $G_1(f) = G_2(f) = \text{const.} \in (0, 1)$  for all  $f \in (\check{f}, \hat{f})$ , and take  $(\check{f}, \hat{f})$  to be the largest such interval such that incumbent firms set prices in any interval  $(\check{f} - \eta, \check{f})$  and  $(\hat{f}, \hat{f} + \eta)$  for any  $\eta > 0$ . Then the headline price of firm 3 either has no probability mass in  $(\check{f}, \hat{f})$ , or has probability mass only on  $\hat{f}$ . But then an incumbent firm can strictly increase profits from consumers who buy by shifting probability mass from  $(\check{f} - \eta, \check{f})$  to  $\hat{f} - \eta/2$  for any  $\eta > 0$ . Since by Lemma 4, the headline price distributions of firms 1 and 2 have no mass point, the loss in demand goes to zero as  $\eta$  gets arbitrarily small. Thus, for a sufficiently small  $\eta > 0$ , this deviation strictly increases profits, contradicting that firms 1 and 2 do not have connected support. We conclude that firms 1 and 2 have connected support.

Denoting  $G_i(\cdot)$  the headline price distribution of firm  $i$ , we use the fact that no firm has a mass point in the headline price distribution and that  $a_i = \bar{a}$  by Lemma 1 to write the profits of firm 1 as

$$\frac{1}{2}\alpha(f_1 - c) + \frac{1}{2}(1 - \alpha) \left[ \frac{1}{2}(1 - G_2(f_1)) + \frac{1}{2}(1 - G_3(f_1)) \right] (f_1 + \bar{a} - c) + \frac{1}{2} \frac{1 - \alpha}{2} (1 - G_2(f_1))(f_1 + \bar{a} - c).$$

The first term are profits from low-value consumers. The second term are profits from high-value consumers who initially observe headline prices of firm 1. The term in squared brackets captures

that with equal probability, these consumers compare prices with firm 2 or firm 3. The third term captures profits from poaching high-value consumers that initially observe  $f_2$ . Exchanging indices 1 and 2 leads to the profits of firm 2. Rearranging terms simplifies the expression to

$$\frac{1}{2}\alpha(f_1 - c) + \frac{1}{2}(1 - \alpha) \left[ (1 - G_2(f_1)) + \frac{1}{2}(1 - G_3(f_1)) \right] (f_1 + \bar{a} - c). \quad (16)$$

Low-value consumers are a profit base for firms 1 and 2 and these firms earn at least  $(1/2)\alpha(f_{max} - c)$  by charging  $f_{max}$ . They must earn at least these profits for almost all prices in the support, implying that total prices  $f_i + \bar{a}$  are almost surely strictly larger than  $c$ . Hence  $f_{min} + \bar{a} > c$ . Therefore the entrant charges the tuple  $(f_{min}, \bar{a})$  and thereby profitably attracts all browsing high-value consumers that see its headline price with probability one. Furthermore, the highest price in the support of firm 3's headline price distribution, denoted  $\bar{f}_3$ , satisfies  $\bar{f}_3 < f_{max}$  for firm 3 to earn positive profits since there is no mass point at  $f_{max}$ .

Therefore, firms 1 and 2 earn profits  $(1/2)\alpha(f_{max} - c)$  when setting the largest price  $f_{max}$ . Hence, for almost all headline prices firms 1 and 2 must earn these profits. Since there is no mass point at  $f_{min}$ , firms earn  $\alpha/2(f_{min} - c) + 3/4(1 - \alpha)(f_{min} + \bar{a} - c)$  when charging  $f_{min}$ . Thus, for firms 1 and 2 to earn  $(1/2)\alpha(f_{max} - c)$  for almost all prices in the support, it must be that  $f_{min} + \bar{a} - c = \frac{2\alpha}{3-\alpha}(f_{max} + \bar{a} - c)$ .

Firm 3 has no profit base and only earns profits from poaching, that is

$$\frac{1}{2}(1 - \alpha) \left[ \frac{1}{2}(1 - G_1(f_3)) + \frac{1}{2}(1 - G_2(f_3)) \right] (f_3 + \bar{a} - c).$$

Since by Lemma 4 firms 1 and 2 play symmetric strategies in equilibrium, we can simplify this expression to

$$\frac{1}{2}(1 - \alpha)(1 - G_2(f_3))(f_3 + \bar{a} - c). \quad (17)$$

We show next that firm 3 attains  $f_{min}$ . Clearly, firm 3 does not charge prices below  $f_{min}$  because at  $f_{min}$  it attracts all browsing high-value consumers. Suppose for the sake of contradiction that firm 3 does not attain  $f_{min}$ . Then there exists an interval  $(f_{min}, f_{min} + \eta)$  for  $\eta > 0$  such that  $G_3(f) = 0$  for any  $f \in (f_{min}, f_{min} + \eta)$ . Take this to be the largest such interval, implying that  $G_3(f_{min} + \eta + \eta_2) > 0$  for any  $\eta_2 > 0$ . Using this, (16), i.e. profits of firms 1 and 2, on the interval  $(f_{min}, f_{min} + \eta)$ , simplifies to

$$\frac{1}{2}\alpha(f_1 - c) + \frac{1}{2}(1 - \alpha) \left[ \frac{3}{2} - G_2(f_1) \right] (f_1 + \bar{a} - c).$$

Using that firms 1 and 2 earn  $\alpha/2(f_{max} - c)$  and rearranging terms, we get

$$\frac{1}{2}(1 - \alpha) [1 - G_2(f_1)] (f_1 + \bar{a} - c) = \frac{\alpha}{2} (f_{max} - f_1) - \frac{(1 - \alpha)}{4} (f_1 + \bar{a} - c).$$

Comparing the left-hand-side to (17), we see that this is equal to the profits of firm 3 when setting a headline price  $f \in (f_{min}, f_{min} + \eta)$ . Furthermore, we see on the right-hand side that this expression



is strictly decreasing in  $f$  (i.e.  $f_1$ ). This implies that if the right-hand side is strictly positive at  $f_1 = f_{min}$ , firm 3, could increase profits from shifting probability mass from  $(f_{min} + \eta, f_{min} + \eta + \eta_2)$  to  $f_{min}$  for a sufficiently small  $\eta_2 > 0$ . Since the right-hand side is indeed strictly positive at  $f_1 = f_{min}$  for all  $\alpha \in (0, 1)$ , this contradicts that firm 3 does not attain  $f_{min}$ . We conclude that firm 3 attains  $f_{min}$ .

This pins down the equilibrium profits of firm 3. If firm 3 sets the lowest price  $f_{min}$ , it earns  $\frac{(1-\alpha)\alpha}{(3-\alpha)}(f_{max} + \bar{a} - c)$ . Hence firm 3 must earn these profits for almost all headline prices in its equilibrium headline price distribution. Using in addition that firms 1 and 2 have a symmetric headline price distribution by Lemma 4, (17) implies that for almost all  $f$  in the support of firm 3's headline price distribution, we have  $G(f) = G_1(f) = G_2(f) = 1 - \frac{2\alpha}{3-\alpha} \frac{f_{max} + \bar{a} - c}{f + \bar{a} - c}$ .

In the next step, we use  $G_2(f)$  and (16) as well as the equilibrium profits of firm 3 to get  $G_3(f) = 1 + \frac{4\alpha}{3-\alpha} \frac{f_{max} + \bar{a} - c}{f + \bar{a} - c} - \frac{2\alpha}{1-\alpha} \frac{f_{max} - f}{f + \bar{a} - c}$  for all  $f \in (f_{min}, \bar{f}_3)$ . It follows from the CDF that  $\bar{f}_3 = f_{max} - \frac{2(1-\alpha)}{3-\alpha}(f_{max} + \bar{a} - c) < f_{max}$ .

Since  $1 - G_3(f) = 0$  for all prices  $f \in [\bar{f}_3, f_{max}]$ , we need to revisit the profits of firm 1 to see that  $G(f) = 1 - \frac{\alpha}{(1-\alpha)} \frac{f_{max} - f}{f + \bar{a} - c}$  for  $f \in [\bar{f}_3, f_{max}]$ .

Overall, we get

$$G(f) = \begin{cases} 1 - \frac{2\alpha}{3-\alpha} \frac{f_{max} + \bar{a} - c}{f + \bar{a} - c} & \text{if } f \in [f_{min}, \bar{f}_3] \\ 1 - \frac{\alpha}{(1-\alpha)} \frac{f_{max} - f}{f + \bar{a} - c} & \text{if } f \in [\bar{f}_3, f_{max}] \end{cases}$$

for firms 1 and 2, and for firm 3

$$G_3(f) = 1 + \frac{4\alpha}{3-\alpha} \frac{f_{max} + \bar{a} - c}{f + \bar{a} - c} - \frac{2\alpha}{1-\alpha} \frac{f_{max} - f}{f + \bar{a} - c} \quad \text{if } f \in [f_{min}, \bar{f}_3],$$

where  $f_{min} = c - \bar{a} + \frac{2\alpha}{3-\alpha}(f_{max} + \bar{a} - c)$  and  $\bar{f}_3 = f_{max} - \frac{2(1-\alpha)}{3-\alpha}(f_{max} + \bar{a} - c)$ .

Using these CDFs at hand, the expected prices set by the firms are as follows. For firms 1 and 2

$$E(f) = f_{min} + \int_{f_{min}}^{\bar{f}_3} \frac{2\alpha}{3-\alpha} \frac{f_{max} + \bar{a} - c}{f + \bar{a} - c} df + \int_{\bar{f}_3}^{f_{max}} \frac{\alpha}{1-\alpha} \frac{f_{max} - f}{f + \bar{a} - c} df,$$

and for firm 3

$$E_3(f) = f_{min} + \int_{f_{min}}^{\bar{f}_3} \frac{2\alpha}{1-\alpha} \frac{f_{max} - f}{f + \bar{a} - c} - \frac{4\alpha}{3-\alpha} \frac{f_{max} + \bar{a} - c}{f + \bar{a} - c} df.$$

Taking into account that  $f_{min}$  and  $\bar{f}_3$  are functions of  $f_{max}$ , and computing the first derivatives, we see that both expected values increase in  $f_{max}$ .

*Step (ii):*  $f_{max} \leq \min\{(1/2)E(f) + (1/2)E_3(f_3) + \bar{a}, v_L\}$ . Similar to Proposition 4, since low-value consumers must prefer to buy at  $f_{max}$ , we have  $f_{max} \leq v_L$ . Since by Lemma 4, low-value consumers prefer studying to browsing and paying  $\bar{a}$ , one has  $f_{max} \leq (1/2)E(f) + (1/2)E_3(f_3) + \bar{a}$ . Overall, we thus have  $f_{max} \leq \min\{(1/2)E(f) + (1/2)E_3(f_3) + \bar{a}, v_L\}$ .

*Step (iii):* If  $f_{max} < v_L$ , then  $f_{max}$  is strictly increasing in  $\alpha$ . For these  $\alpha$ , we know that  $f_{max}$  is determined by  $f_{max} - (1/2)E(f) - (1/2)E_3(f_3) - \bar{a} = 0$ . Applying the implicit-function theorem on this expression, we see that

$$\begin{aligned} \frac{\partial f_{max}}{\partial \alpha} = & \left[ 1 - \frac{1}{2} \int_{f_{min}}^{\bar{f}_3} \frac{2\alpha}{(3-\alpha)(f+\bar{a}-c)} df - \frac{1}{2} \int_{\bar{f}_3}^{f_{max}} \frac{\alpha}{(1-\alpha)(f+\bar{a}-c)} df - \frac{1}{2} \int_{f_{min}}^{\bar{f}_3} \frac{2\alpha(1+\alpha)}{(1-\alpha)(3-\alpha)(f+\bar{a}-c)} df \right]^{-1} \\ & \cdot \left[ \frac{1}{2} \int_{f_{min}}^{f_{max}} \frac{\partial(1-G(f;\alpha))}{\partial \alpha} df + \frac{1}{2} \int_{f_{min}}^{\bar{f}_3} \frac{\partial(1-G_3(f;\alpha))}{\partial \alpha} df \right] \end{aligned} \quad (18)$$

The second term is positive since all CDFs decrease in  $\alpha$  at any price in the support. Using the same algebra as in the proof of Proposition 4, the first term simplifies to

$$1 - \frac{2\alpha}{(1-\alpha)(3-\alpha)} \ln \left( \frac{1+\alpha}{2\alpha} \right) - \frac{\alpha}{2(1-\alpha)} \ln \left( \frac{3-\alpha}{1+\alpha} \right).$$

Standard Algebra shows that this expression decreases in  $\alpha$  and approaches zero as  $\alpha$  approaches 1. Thus, we conclude that if  $f_{max} < v_L$ ,  $f_{max}$  strictly increases in  $\alpha$ .

*Step (iv):* There exists a unique  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  if and only if  $\alpha \geq \alpha^*$ . That there exists a unique  $\alpha^* \in [0, 1]$  such that  $f_{max} = v_L$  if and only if  $\alpha \geq \alpha^*$  follows from step (iii).

We already established that  $E(f)$  and  $E_3(f)$  increase with  $f_{max}$ . In the limit when  $\alpha \rightarrow 1$ , we can see immediately that  $f_{min} \rightarrow f_{max}$  and  $\bar{f}_3 \rightarrow f_{max}$ . It follows that in the limit,  $E(f) = E_3(f_3) = f_{max}$ , implying that low-value consumers strictly prefer studying to browsing for large enough  $\alpha$ . Then firms set the largest possible price  $f_{max} = v_L$  for large enough  $\alpha$ , for otherwise a firm could move probability mass to  $v_L$  and strictly increase profits. Thus  $\alpha^* < 1$ .

We show next that as  $\alpha \rightarrow 0$ ,  $v_L > (1/2)E(f) + (1/2)E_3(f_3) + \bar{a}$  which implies that  $f_{max} = (1/2)E(f) + (1/2)E_3(f_3) + \bar{a} < v_L$ . When  $\alpha \rightarrow 0$ ,  $f_{min} \rightarrow c - \bar{a}$  and  $f_{3,min} \rightarrow c - \bar{a}$ . Looking at  $E(f)$ , we see that the integrands go to zero as  $\alpha \rightarrow 0$ , and since  $f_{max}$  is bounded by  $v_L$ , this implies that as  $\alpha \rightarrow 0$ ,  $E(f) \rightarrow f_{min} = c - \bar{a}$ . Similarly, the integrand of  $E_3(f)$  goes to zero as  $\alpha \rightarrow 0$  and  $E_3(f) \rightarrow f_{min} = c - \bar{a}$  as  $\alpha \rightarrow 0$ . Overall, we get that as  $\alpha \rightarrow 0$ ,  $(1/2)E(f) + (1/2)E_3(f_3) + \bar{a} \rightarrow c < v_L$ .

Since by step (iii),  $f_{max}$  is strictly increasing if  $f_{max} < v_L$ , and since  $f_{max} = v_L$  is constant for large enough  $\alpha$ , we conclude that there exists a unique  $\alpha^* \in (0, 1)$  such that  $f_{max} = v_L$  if and only if  $\alpha \geq \alpha^*$ .  $\square$

**Proof of Proposition 12.** Denote the share of high-value consumers that become more informed by  $\lambda$ ; for brevity we refer to a high-value consumer who becomes more informed simply as becoming informed throughout the proof. Similarly, we refer to a high-value consumer who becomes less informed as uninformed. In case all high-value consumers become (more) informed, we are

in our baseline model for which Proposition 4 characterizes the equilibrium. Given this equilibrium headline-price distribution, these correspond to equilibria of the overall game if all high-value consumers want to become informed, which obviously holds for sufficiently small  $s$ . By the intermediate value theorem, there exist a value of  $s$  at which all high-value consumers are just willing to become informed.

Now consider introducing a headline price cap  $f_{cap}$  that is weakly below the maximal equilibrium headline price ( $f_{max} = \min\{E(f) + \bar{a}, v_L\}$ ) from Proposition 4 and strictly above  $c$ . For any pair of  $f_{cap}, \lambda$  in which  $\lambda > 0$ , we now solve for a symmetric pricing equilibrium in which informed high-value consumers browse on the equilibrium path and low-value consumers study for prices below  $f_{cap}$ . The argument parallels that from the proof of Proposition 4.

Since  $f_{cap} \leq f_{max}$  and there can be no mass point in the symmetric equilibrium headline price distribution, a firm setting the highest headline price in the support of the equilibrium headline price distribution  $G$  sells to all low-value as well as to uninformed high-value consumers but does not sell to informed high-value consumers. If this maximal price was below  $f_{cap}$ , the firm could deviate and set  $f_{cap}$ , which would increase profits. Thus,  $f_{cap}$  is in the support of the equilibrium headline price distribution, and therefore the firms' equilibrium profits

$$\pi = \alpha(f_{cap} - c) + (1 - \alpha)(1 - \lambda)(f_{cap} + \bar{a} - c), \quad (19)$$

where the first term are the profits from the studying low-value consumers who satisfy conditions to avoid  $\bar{a}$  and the second term are the profits from uninformed high-value consumers who pay  $\bar{a}$ .

We next characterize the equilibrium headline-price distribution  $G(f)$ . For later ease of exposition, we will denote by  $x(f) = (1 - G(f))$  the probability that another firm charges a larger price than  $f$ . The equilibrium headline-price distribution is pinned down by

$$\frac{1}{I}\pi = \frac{1}{I} [\alpha(f - c) + (1 - \alpha)(1 - \lambda)(f + \bar{a} - c) + 2(1 - \alpha)\lambda(f + \bar{a} - c)x(f)]. \quad (20)$$

The first two terms are profits from non-browsing consumers, and the third term profits from competing for informed high-value consumers, which browse. Substituting equation 19 into 20 yields

$$\underbrace{(\alpha + (1 - \alpha)(1 - \lambda))}_{=\hat{\alpha}}(f_{cap} - c) = \underbrace{(\alpha + (1 - \alpha)(1 - \lambda))}_{=\hat{\alpha}}(f - c) + 2\underbrace{(1 - \alpha)\lambda}_{=(1 - \hat{\alpha})}(f + \bar{a} - c)(1 - G(f)).$$

Thinking of the share non-browsing consumers  $\hat{\alpha}$  as generalizing the share  $\alpha$  of non-browsing (low-value) consumers in our benchmark model, the above equation characterizing the equilibrium headline-price distribution is identical to equation 1 in the proof of Proposition 4 that characterizes the headline-price distribution as a function of an exogenously given maximal price and consumer search strategy. Thus,  $G(f)$  satisfies the same properties. This implies that it is continuous and differentiable over its support  $[f_{min}, f_{cap}]$ , and hence also that  $x(f)$  is continuous and differentiable over its support  $[0, 1]$ . Step (iii) of the proof of Proposition 4 establishes that in equilibrium (absent a price cap)  $f_{max} = \min\{E(f) + \bar{a}, v_L\}$ , and Step (iv) that  $f_{max}$  is increasing in  $\alpha$ . Hence,  $f_{cap} \leq f_{max}(\alpha) \leq f_{max}(\hat{\alpha})$ . In addition, since imposing a binding cap on the headline price has the

same effect on the equilibrium headline-price distribution as lowering  $v_L$ , the proof of Proposition 4 implies that low-value consumers prefer studying for any  $f_{cap} \leq f_{max}(\hat{\alpha})$ , and informed high-value consumers continue to prefer browsing.

To calculate the high-value consumers incentives to become informed, it is useful to rewrite the above equilibrium condition in order to obtain the headline price  $f$  as a function of the probability  $x$  that one competitor draws a larger price

$$f(x) = \frac{[1 - \lambda + \lambda\alpha]f_{cap} - 2(1 - \alpha)\lambda x(\bar{a} - c)}{1 - \lambda + \lambda\alpha + 2(1 - \alpha)\lambda x}.$$

Differentiating gives rise to

**Lemma 6.**

$$\frac{\partial f(x)}{\partial x} = -\frac{2(1-\alpha)\lambda(1-\lambda+\alpha\lambda)(f_{cap}+\bar{a}-c)}{[1-\lambda+\lambda\alpha+2(1-\alpha)\lambda x]^2} \leq 0.$$

$$\frac{\partial^2 f(x)}{\partial x \partial f_{cap}} = -\frac{2(1-\alpha)\lambda(1-\lambda+\alpha\lambda)}{[1-\lambda+\lambda\alpha+2(1-\alpha)\lambda x]^2} \leq 0.$$

$$\frac{\partial^2 f(x)}{\partial x \partial \lambda} = -\frac{2(1-\alpha)(f_{cap}+\bar{a}-c)[1-\lambda+\lambda\alpha-2(1-\alpha)\lambda x]}{[1-\lambda+\lambda\alpha+2(1-\alpha)\lambda x]^3}.$$

Denote by  $f_I$  and  $f_U$  the expected price of more informed and less informed high-value consumers respectively. We first compute  $f_I$ . Informed consumers draw two headline prices. Since all firms charge  $\bar{a}$ , they buy the product with the lower headline price. The CDF of the minimum of two headline prices is  $1 - x(f)^2$ , so the PDF is  $-2x(f)x'(f)$ . Computing the expected value and doing a change of variables, one has

$$f_I = -\int_{f_{cmin}}^{f_{cap}} f 2x(f)x'(f)df = -\int_1^0 f(x)2xdx = \int_0^1 f(x)2xdx.$$

To compute  $f_U$ , recall that uninformed consumers draw one headline price, distributed according to the PDF  $-x'(f)$ . This leads to

$$f_U = -\int_{f_{cmin}}^{f_{cap}} f x'(f)df = \int_0^1 f(x)dx.$$

Hence, the incentive to become informed

$$f_U - f_I = \int_0^1 f(x)[1 - 2x]dx = -\int_0^1 \frac{\partial f(x)}{\partial x}[x - x^2]dx \geq 0,$$

where we use integration by parts to come from the second to the third expression, and Lemma 6 to establish the inequality. Furthermore, the inequality is strict if  $\alpha \in (0, 1)$  and  $\lambda > 0$ .

Differentiating  $f_U - f_I$  and applying Lemma 6 yields

**Lemma 7.**

$$\frac{\partial(f_U - f_I)}{\partial f_{cap}} = - \int_0^1 \frac{\partial^2 f(x)}{\partial x \partial f_{max}} [x - x^2] dx = \int_0^1 \frac{2(1-\alpha)\lambda(1-\lambda+\alpha\lambda)}{[1-\lambda+\lambda\alpha+2(1-\alpha)\lambda x]^2} [x - x^2] dx \geq 0.$$

$$\frac{\partial(f_U - f_I)}{\partial \lambda} = - \int_0^1 \frac{\partial^2 f(x)}{\partial x \partial \lambda} [x - x^2] dx = \int_0^1 \frac{2(1-\alpha)(f_{max} + \bar{a} - c)[1-\lambda+\lambda\alpha-2(1-\alpha)\lambda x]}{[1-\lambda+\lambda\alpha+2(1-\alpha)\lambda x]^3} [x - x^2] dx.$$

Let  $f_{cap} = f_{max}(\alpha)$  so that initially the cap is nonbinding. Let  $s$  equal the difference  $f_U - f_I$  for the case in which all high-value consumers are informed (i.e. for  $\lambda = 1$ ). In this case, a high-value consumer is indifferent between becoming informed or not if all other high-value consumers become informed. Therefore, there exists an equilibrium in which all high-value consumers become informed.

For any  $f_{cap}$ , there exists an equilibrium in which a share  $\lambda$  of high-value consumers becomes informed if

$$f_U(\lambda, f_{cap}) - f_I(\lambda, f_{cap}) - s = 0.$$

Using the implicit-function theorem, we obtain

$$\left. \frac{d\lambda}{df_{cap}} \right|_{\lambda=1} = - \frac{\left. \frac{\partial(f_U - f_I)}{\partial f_{cap}} \right|_{\lambda=1}}{\left. \frac{\partial(f_U - f_I)}{\partial \lambda} \right|_{\lambda=1}} = - \frac{\alpha \int_0^1 \frac{x-x^2}{[\alpha+2(1-\alpha)x]^2} dx}{(f_{cap} + \bar{a} - c) \int_0^1 \frac{(\alpha-2(1-\alpha)x)(x-x^2)}{[\alpha+2(1-\alpha)x]^3} dx}. \quad (21)$$

For future reference, since Lemma 7 establishes that  $\left. \frac{\partial(f_U - f_I)}{\partial f_{cap}} \right|_{\lambda=1} \geq 0$  for all  $\alpha \in (0, 1)$ , a necessary condition for  $\left. \frac{d\lambda}{df_{cap}} \right|_{\lambda=1} > 0$  is that  $\left. \frac{\partial(f_U - f_I)}{\partial \lambda} \right|_{\lambda=1} < 0$ . Profits respond to a change in  $f_{cap}$  according to

$$\left. \frac{d\pi}{df_{cap}} \right|_{\lambda=1} = \alpha - (1 - \alpha)(f_{cap} + \bar{a} - c) \left. \frac{d\lambda}{df_{cap}} \right|_{\lambda=1}.$$

Substituting Equation 21 into the above equation yields

$$\left. \frac{d\pi}{df_{cap}} \right|_{\lambda=1} = \alpha \left\{ 1 + (1 - \alpha) \frac{\int_0^1 \frac{x-x^2}{[\alpha+2(1-\alpha)x]^2} dx}{\int_0^1 \frac{(\alpha-2(1-\alpha)x)(x-x^2)}{[\alpha+2(1-\alpha)x]^3} dx} \right\}.$$

Observe that the numerator of the fraction of integrals in the above expression is positive and bounded away from zero for any  $\alpha$ , while the denominator of the fraction is positive for  $\alpha = 1$  and negative for  $\alpha = 0$ . Since  $[\alpha + 2(1 - \alpha)x]^3$  is a continuous function in  $\alpha$ , there exists some  $\alpha' \in (0, 1)$ , for which it is zero, and the function

$$\int_0^1 \frac{(\alpha - 2(1 - \alpha)x)(x - x^2)}{[\alpha + 2(1 - \alpha)x]^3} dx$$

crosses zero from below. Hence, for  $\alpha < \alpha'$  but close enough to  $\alpha'$ , the derivative of the profit function with respect to the price cap is negative, and hence there exists binding price caps that increase profits and decrease consumer welfare. (Numerically evaluating  $\left. \frac{d\pi}{df_{cap}} \right|_{\lambda=1}$  shows that the derivative of the profit function is negative for  $\alpha < 0.365$ .) Hence, for such  $\alpha$ , introducing a binding price cap increase equilibrium profits and, thus, makes consumers worse off.

Finally, the equilibrium is stable since  $\left. \frac{\partial(f_U - f_I)}{\partial\lambda} \right|_{\lambda=1} < 0$  for such  $\alpha$ . □

**Proof of Proposition 13.** We begin by establishing that  $f_i = v$  and  $f_i + a_i = v + \bar{a}$  for all  $i$ , and all consumers studying match values is an equilibrium outcome.

Consumers who study and have the high valuation  $v + \bar{a}$  for the premium product buy the premium product if and only if  $a_i \leq \bar{a}$  and  $f_i + a_i \leq v + \bar{a}$ . Consumers who study and have the low valuation for the premium product  $v$  do not buy the premium whenever  $a_i > 0$  and do not purchase the base product when  $f_i > v$ . Hence, as long as all consumers study, it is a best response for firm  $i$  to charge  $f_i = v$  and  $f_i + a_i = v + \bar{a}$ .

Denote the probability that the consumer prefers the premium version by  $\alpha$ . Given that all firms charge  $f_i = v$  and  $f_i + a_i = v + \bar{a}$ , we now show that it is a best response for consumers to study. Browsing and buying the premium product leads to  $v + \alpha\bar{a} - (v + \bar{a}) \leq 0$ , while browsing and buying the basic product induces  $v - v \leq 0$ . Thus, no consumer benefits from deviating in her search strategy when firms charge  $f_i = v$  and  $f_i + a_i = v + \bar{a}$ .

Finally, if firm  $i$  deviates and charges different prices it does not attract any consumers from its rivals. And since it extracts the entire ex post social surplus from the consumers that are initially assigned to it, rationality of its consumers together with the fact that they observe both prices implies that there is no profitable deviation for firm  $i$ .

We now show that marginal cost pricing, i.e.  $f_i = 0$  and  $a_i = c$  for all  $i$  is not an equilibrium. Observe that the payoff of a consumer who browses and buys the premium product from a firm that engages in marginal-cost pricing is  $v + \alpha\bar{a} - c$ , and the payoff of a consumer who browses and buys the basic product is  $v$ . This is strictly less than the payoff of a consumer who studies and buys from a firm that engages in marginal-cost pricing, which gives  $\alpha(v + \bar{a} - c) + (1 - \alpha)v$ . But this implies that for sufficiently small  $f_i > 0$ , it is still strictly optimal for the consumer to study and buy when the firm charges  $f_i, a_i = c$ . Hence, there is a profitable deviation for firm  $i$ . □