

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

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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. We study a market in which each firm chooses two price components, a headline price and an additional price, and a consumer can either fully understand the offer of one firm (studying), or look at only the headline prices of two firms (browsing). Regulations capping the additional price or standardizing conditions under which the additional price can be charged lower prices and increase consumer welfare in a variety of environments. The core mechanism is simple: because consumers do not need to worry about regulated features, they can devote more attention to browsing, enhancing competition. Extending our model to multiple markets, we 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. As an auxiliary positive prediction, we show 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, safety, or environmental impact 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, including for fully rational as well as naive consumers, 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 homogenous 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 the additional price 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 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. Intuitively, it is now safe for consumers to redirect their attention from studying to browsing, leading firms to compete.

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 find it costless to fulfill a firm's condition for avoiding the additional price, while high-value consumers find fulfilling most conditions 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.

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 Section 4, we identify outcomes when a regulation capping the additional price is in place. 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 have a dominant strategy of browsing. 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., 2016), and our model also clarifies why entry may not solve the problem. 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., 2016), 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 turn to our main interest: 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. As a potential application, Bar-Gill (2009) argues that the complexity of fees lenders could impose in the subprime mortgage market rendered comparison shopping exceedingly costly, so that—despite the seemingly competitive nature of the market by conventional measures of concentration—margins were very high.

We also analyze a kind of plain-vanilla regulation akin to that suggested by Barr et al. (2008) and Thaler (“Mortgages Made Simpler,” New York Times, July 4, 2009). Suppose that 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

regulation has no effect—high-value consumers pay and low-value consumers avoid the additional price—so it can be considered a nudge. Yet because low-value consumers can now simply not consider alternatives to the plain-vanilla product, they can browse, inducing perfect competition between firms.

These insights yield a novel and powerful competition-policy-based argument for regulating product and contract features: the right policies simplify consumers' lives and allow them to do more comparison shopping, exerting a beneficial indirect effect on the functioning of markets. This view 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. Under our view, one reason that developed markets often function better than developing markets may be the heavy regulation of products and contracts. 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.

Of course, the message that regulation of additional prices or other secondary features can have a substantial pro-competitive effect must be balanced against classical concerns regarding regulation, so that our results are not intended to endorse the indiscriminate regulation of secondary features. Nevertheless, our framework suggests that the correct response to this recognition is not the market-by-market fine-tuning of regulations. 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 (legal) principles.

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, strengthening the argument that our framework calls for an overarching legal principle rather than isolated interventions.

In Section 7, we discuss related literature. While a large literature studies the market implications of costly search, and a small but growing literature analyzes the implications of inattention in markets, past research has not analyzed the implications of the tradeoff between browsing and studying for the performance and regulation of markets. We conclude in Section 8 by identifying some important further questions raised by our framework.

2 Example

In this section, we illustrate the core mechanism behind our model’s policy implications through a simple example. The example covers situations in which the additional price is unavoidable. In the labor market, for instance, all workers are affected not just by the wage, but also by the working conditions—such as safety—of a job. 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 market for mutual funds, all investors pay not just the front load, but also the management fee

charged by a fund. In the rest of the paper, we consider the empirically just as relevant situations in which the additional price is avoidable; such situations are analytically more complicated because consumers make endogenous decisions of whether to avoid the additional price.

Suppose that there are $I \geq 2$ firms selling a homogenous 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 price of $f_i + a_i$. 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.

Although this market features homogenous firms engaged in price competition, it does not work for consumers:

Proposition 1. *In any equilibrium, a consumer can only buy at her value.*

In equilibrium, each firm acts as a monopolist, extracting all rents from all consumers who purchase. Intuitively, in equilibrium consumers 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 illustrate the attention-leveraging power of regulation, consider a symmetric pure-strategy equilibrium consistent with Proposition 1. In such an equilibrium, all firms charge prices f, a satisfying $f + a = v$. Suppose that the social planner imposes a price cap of $\bar{a} > a$, so that firms must choose additional prices on the interval $[0, \bar{a}]$. We interpret the cap as any regulation that restricts the extent to which consumers can be hurt by hidden features 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. 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 symmetric equilibrium with a price cap, all consumers buy at cost.*

The competition-inducing effect of regulation arises from two mechanisms. First, regulation makes browsing more effective in selecting between products, guaranteeing at least some competition between firms. In an unregulated market, any cut in the headline price can be undone by an increase in the additional price, so that 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.¹

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.

3 Basic Model

In this section, we introduce our main model, considering situations in which the additional price can be avoided, and beginning with a regulated market.

3.1 Formal Setup

There are $I \geq 2$ firms selling a homogenous 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

¹ 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 ϵ , therefore, firm i 's deviation is profitable.

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 and only if $\tilde{\gamma} \neq \gamma_i$.

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 , 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 γ_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).² A consumer can only buy from a firm if she has seen that firm's headline price. For simplicity, we suppose that a consumer purchases when indifferent between purchasing and not purchasing.

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.

² 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—with important effects for unemployment explored by Kaplan and Menzio (2016)—but Mullainathan and Shafir (2013) would contend that low-income consumers have higher search costs because they lead busier lives.

Furthermore, we impose two mild equilibrium-selection assumptions. First, we posit that 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.³ Second, we assume that if consumers observe an off-equilibrium $f_i \leq v_L$, then (i) they realize that by sequential rationality, the choice of A_i and Γ_i can only affect the profits earned from a subset of consumers; and (ii) they believe the choice of A_i and Γ_i to be profit-maximizing given that some such consumers purchase. This assumption allows us to argue that if a (low-value) consumer observes an off-equilibrium cut in the headline price, then she does not infer good news about a_i and γ_i and thereby conclude that the value of studying has decreased.⁴

To see how the ingredients of our model can be mapped to an application, consider mobile phones. In this application, 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 γ_i as the specific conditions regarding what usage is covered in the basic 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.

3.2 Discussion of Modeling Assumptions

To set up a tractable model of the tradeoff between browsing and studying, we have made a number of particular assumptions above. We fully analyze this main model by considering both the existence and the uniqueness of equilibria. In addition, to establish the relevance of our model for a range of different settings, we examine the implications of many modifications to our assumptions. We now discuss these modifications, and later argue or formally show that they leave the paper's main insights unchanged. When analyzing alternative models, however, we do not consider the

³ An alternative equilibrium-selection assumption we could use for the same purpose is that a small fraction of consumers are fully informed.

⁴ 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.

technically difficult issue of uniqueness, but only look for equilibria of the form we have found in our main model.

Tradeoff between Browsing and Studying. Our model builds in a strong form of the tradeoff between browsing and studying: whenever a consumer chooses not to study, by assumption she uses the attention so saved to browse. Furthermore, since we model a single product market, the tradeoff between browsing and studying must occur at the product level. We think of both of these assumptions as capturing in a stylized way broader tradeoffs. First, even in our model, it is plausible to assume 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.⁵ This leaves the logic of our model essentially unchanged. Second, more importantly, the tradeoff between browsing and studying is likely to occur not at the level of a single purchase, but when having to make many purchases: if a consumer studies many products, then she does not have sufficient attention left to browse a lot. In Section 6, we model such a broad tradeoff by assuming that the consumer makes purchases in multiple markets, and can use her limited attention for any combination of studying and browsing in these markets. We show that our main points survive, and derive additional insights.

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 observing any price after the first two has positive and increasing—but finite—cost.

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

⁵ A specific two-market example that features our tradeoff between browsing and studying is the following. One market is as above, but it is monopolistic, and parameters are such that it is optimal for the monopolist to 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.

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.

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.

4 Baseline Equilibrium

4.1 High Prices for Low-Income Populations: Main Result and Discussion

Our model has a unique equilibrium outcome with the following properties:⁶

Proposition 3. *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 α .*

⁶ 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 γ_i without studying to learn it.

To take advantage of browsing consumers, firm i sets $a_i = \bar{a}$, and to make sure that a consumer is only guaranteed to avoid a_i by studying, it randomizes γ_i . Since high-value consumers prefer not to avoid the additional price, they browse for any equilibrium up-front price.⁷ 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.

The differential behavior between the consumer types leads to a theoretically interesting and 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 3 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 α 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 α is sufficiently low, the competition for consumer inattention described above also comes into play. Again similarly to Varian, the dual objective of exploiting price-insensitive low-value

⁷ 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 $v_L < v_H - \bar{a}$. 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.

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 3 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).⁸ 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, Agarwal et al., 2016). 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 with limited attention. In Appendix A, we formulate a model that captures this disadvantage, and

⁸ For instance, Agarwal et al. (2016) 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).

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. Hence, entry is unlikely to do much for populations with many low-value consumers.

4.2 Robustness

The qualitative features of the above equilibrium are robust to several alternative specifications we have described in Section 3.2. Suppose first 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.⁹ We show that the equilibrium characterized in Proposition 3 survives qualitatively unchanged, and in fact features interesting comparative statics:

Proposition 4. *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

⁹ We continue to assume that high-value consumers’ cost of satisfying almost any condition is greater than \bar{a}_H , and that $v_L + \bar{a}_H \leq v_H$.

price than low-value consumers, it is no longer generally true that high-value consumers pay higher 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 α 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 3 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) and Heidhues et al. (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.

The extreme form of convex attention costs we have assumed—that observing two prices is free, but observing anything else is impossible—is also not crucial for our results. In Appendix B, we

consider a generalization in which the cost of observing price number n is s_n , with $s_1 = s_2 = 0$, $s_3 > 0$, and $s_{n+1} \geq s_n$ for all n . We show that the equilibrium identified in Proposition 3 survives qualitatively unchanged. Specifically, if $s_3 \geq \bar{a}$, then an equilibrium with the same properties exists; and if $s_3 < \bar{a}$, then an equilibrium with the same properties exists, except that for $\alpha < \alpha^*$ the condition tying down f_{max} becomes $f_{max} = E[f] + s_3$. Intuitively, low-value consumers now have a new option: instead of studying their product, they can—at cost s_3 —browse, find another product, *and* study that one. For the equilibrium price distribution in Proposition 3, this option saves weakly less than \bar{a} , so for $s_3 \geq \bar{a}$ it is irrelevant. For $s_3 < \bar{a}$, however, the threat that low-value consumers choose this option leads firms to lower prices until $f_{max} \leq E[f] + s_3$, with the constraint binding when there are sufficiently many high-value consumers.

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 the settings we have analyzed above.

5 The Effects of Regulation

We now turn to the main message of our paper: that regulation can lead consumers to substitute their search efforts toward browsing, enhancing competition. We demonstrate this point 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 interpret the cap \bar{a} on the additional price as arising from regulation that restricts the extent to which consumers can be hurt by hidden features after agreeing to purchase, and ask what happens without such protection. This interpretation of the cap is consistent with regulations that limit the additional fees imposed for

bank accounts, credit cards, investments, and other products and services.

Formally, we modify the model of Section 3.1 in two ways. First, crucially, we assume that there is no cap on the additional price. Second, for simplicity, we assume that high-value consumers cannot avoid the additional price at any cost. This deregulation leads to a total collapse in competition:

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

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. The reason is the same 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.

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.

Plain-Vanilla Regulation Leads to Perfect Competition. The comparison of Propositions 3 and 5 establishes that regulation of additional fees can increase competition by changing consumer search behavior. Completely different regulations can also engage the mechanism of empowering consumer search. As a potentially important example, we consider a type of plain-vanilla regulation 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 γ_i , it must ask consumers to explicitly opt in and agree to the change, which consumers can refuse without needing to study the offer. This means that a browsing consumer faces the condition γ_d , while a studying consumer can select between γ_d and γ_i . 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—and hence can be considered a nudge. Nevertheless, the policy has a drastic effect:

Proposition 6. *With a plain-vanilla policy, 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 do not opt in and—no longer needing to study to avoid the additional price—can now browse, inducing perfect competition between firms. This means that in two senses, the plain-vanilla regulation benefits low-value consumers more than high-value consumers. 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.

Robustness. Propositions 5 and 6 extend to all variants of our model we have discussed in Section 3.2 and analyzed in Section 4.2, so long as in the deregulated market of Proposition 5 firms can charge both types of consumers an arbitrarily high additional price.¹⁰ Furthermore, while the variations have subtle effects on the baseline equilibrium, they do not affect the logic of deregulation or plain-vanilla regulation at all.

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 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 (Section 4.2). 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. And if the education helps

¹⁰ 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.

naive consumers who are aware of the additional price better avoid the additional price, then it helps these consumers, but by Corollary 1 it does not otherwise affect market outcomes.¹¹

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) makes the case powerfully: she argues that while regulation is often thought to reduce freedom, in the development context it actually increases 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).¹² Our results say that the opposite may well be the case: policies can enhance consumer welfare not only through their direct

¹¹ In contrast, general education that lowers consumers’ costs of search—thereby allowing them to do more browsing or studying—does tend to improve outcomes.

¹² 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).

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). 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.¹³

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. As a practical example, the German Civil Code 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 EU applies similar principles.¹⁴

¹³ 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.

¹⁴ 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 and <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0013:en:HTML>, respectively.

Our model says that such legal principles are not only a matter of ensuring fairness—which is how the principles are couched—but also a matter of facilitating competition.

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, and discuss the efficiency implications of the type of competition-enhancing policies we have identified. A decrease in prices brought about by competition can have the classical welfare-enhancing effect of drawing more consumers into the market. Inducing consumers to browse can also facilitate efficiency in matching if consumers have heterogeneous tastes for the basic versions of a product. In contrast, if a consumer needs to study to determine whether she likes the basic or the premium version of the product, then a standardization that bans the premium version enhances competition at the cost of lowering efficiency.

6 Multiple Markets

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. In doing so, we consider a more realistic version of the tradeoff between browsing and studying than we did in our single-market model: 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. 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, each firm operating in one market, and consumers interested in buying

one product in each 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 an infinitely high valuation for the products ($v_L = v_H = \infty$). 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.

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.

As with other extensions, we do not fully characterize the set of equilibria—which in fact appears intractable for the current model—but look for the types of equilibria we have found in our basic model. In particular, we ask whether an equilibrium along the lines of Proposition 3, or an equilibrium with competitive pricing akin to those induced by our regulations, 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 α .*

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 γ_i , it must ask consumers to explicitly opt in and agree to the change, 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 (in this model 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 discuss previous theoretical research related to our 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. Accordingly, the main insights of the research

we summarize are largely distant from ours.

7.1 Search

Even beyond research already discussed in Section 5.2, our paper is related to the literature on consumer search. The vast majority of this literature assumes that (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.¹⁵ 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) assume convex search costs to study search fatigue. And replacing (iii), Haan et al. (2015) and Armstrong (2016) have started to investigate directed search. We modify all three of these assumptions.

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.¹⁶

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, 2006, Armstrong and Chen, 2009, Bachi and Spiegler, 2015, Grubb, 2015), 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

¹⁵ 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).

¹⁶ In Matějka and Tabellini's (2016) model of electoral competition with inattentive voters, politicians affect the distribution of outcomes for voters, but even there they only choose the mean, not the variance of the distribution.

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 firm. Roesler 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.¹⁷

7.3 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 not aware 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

¹⁷ More distantly related, the literature on choice complexity studies obfuscation by firms, taking consumer behavior as given. See Spiegel (2016) for a review. In our setting, the endogeneity of consumer behavior is crucial.

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.

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. Unlike in our setting, the regulation does not work through influencing consumers’ search behavior, and a non-binding regulation does not affect equilibrium outcomes.

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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A 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 3, without the entrant the incumbents’ profits are increasing in the share of low-value consumers, α . One might naturally conjecture that the entrant’s expected profit—and hence its willingness to enter—is therefore also increasing in α . Instead:

Proposition 9. *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 α .*

Proposition 9 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 α for low α , but decreasing in α for high α . When α is small, most consumers browse, and the resulting Bertrand-type competition leaves the entrant with low profits. When α 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 α , 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 9 implies not only that for high α 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.^{18,19}

¹⁸ To understand these results in more detail, notice that for high α —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.

¹⁹ 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.

B Searching More Prices

For simplicity, in the model from Section 3 consumers observe only two prices. First, they see the headline price of their initially assigned product. Second, they can decide whether to study their initially assigned product to learn conditions and the additional price, or to browse the headline price of another one. We now relax this assumption and assume consumers can at a cost learn further prices.

We 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 . 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 3 are robust to this specification.

Proposition 10. *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 α .*

The main logic from Proposition 3 applies again 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 was not relevant 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 3 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. α 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 4, 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 3 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. Reasonable extensions—commonly assumed in the search literature—that induce variation in benefits for high-value consumers 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, some share of consumers with zero search cost, or intrinsic benefits from browsing (shoppers), induces some variation in headline prices. This price variation would in turn induce high-value consumers to pay (low enough) s_2 and browse as well.

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.²⁰ 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.

²⁰In the equilibrium we solve for, low-value consumers would want to become more informed for any $s \leq \bar{a}$.

Proposition 11. *There exist stable equilibria and parameters such that introducing a cap on the headline price increases firms' equilibrium profits and makes consumers worse off.*

D Competitiveness versus Efficiency

Our results on policy identify the effect of regulation on the *competitiveness* of the market in models where regulation does not affect efficiency. In this section, we 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 homogenous—guaranteeing efficiency—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 12. *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

Consider an f_i in the support of firm i 's headline price distribution. Let $A_i(a_i|f_i)$ be the corresponding conditional equilibrium price distribution over a_i , and for a given pair of prices f_i, a_i let $\Gamma_i(\gamma_i|a_i, f_i)$ be the corresponding conditional equilibrium distribution over conditions γ_i . A firm i 's strategy is a collection $(G_i, \{A_i\}_{f_i}, \{\Gamma_i\}_{f_i, a_i})$, where G_i is a cumulative distribution function over headline prices, and $\{A_i\}_{f_i}$ a set of conditional additional price distributions, and $\{\Gamma_i\}_{f_i, a_i}$ a set of conditional condition distributions.

Proof of Proposition 1. We begin by considering the case without regulation and show that consumers can only buy at total prices equal to their valuation.

We show first that in equilibrium almost all buying consumers must study the offer of their initial firm. Suppose otherwise, i.e. a positive mass of consumers $\eta > 0$ browses offers for some positive mass of equilibrium headline prices and then buys with positive probability. Then some firm i attracts a positive mass of browsing consumers with positive probability conditional on charging some given f_i . This firm can profitably deviate and charge f_i and increase the corresponding a_i by an arbitrarily large number enabling it to earn unbounded profits, contradicting equilibrium. We conclude that almost no browsing consumer buys with positive probability.

Any high-value consumers who studies accepts any offer for which $f_i + a_i \leq v_H$. Similarly, studying low value consumers accept any offer with $f_i \leq v_L$. Hence, in equilibrium firms must charge $f_i + a_i = v_H$ and $f_i = v_L$ if a positive mass of consumers studies. And given that all firms charge $f_i + a_i = v_H$ and $f_i = v_L$, it is a best response for consumers to study and buy. \square

Proof of Proposition 2. We next consider the equilibrium with regulation in which $a_i \leq \bar{a}$, and show that all consumers buy at cost. 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_H with probability one. Step (iii) establishes that all consumers browse at all up-front 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 $f_i < v_H - \bar{a}$, 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 $f_i \geq v_H - \bar{a}$, 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. Conditional on such a f_i , firm i cannot charge a total price strictly below v_H and sell to a positive mass of consumers. In this case firm i could increase a_i by a small amount and still charge a total price below v_H ; 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 $f_i + a_i \geq v_H$ 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 $f_i \in (c - \bar{a}, v_H - \bar{a})$ and $a_i = \bar{a}$, for which all consumers strictly prefer buying. And because in the candidate equilibrium some consumers buy with probability zero, this attracts some consumers with positive probability, a contradiction. Next, we establish that for such an f_i , $f_i + a_i = v_H$ with probability one. For otherwise, since it charges total prices below v_H 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_H , 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 $f_i = v_H - \bar{a} - \eta$ 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 $f_i + a_i < v_H$ with probability one. Suppose otherwise, that is some firm i sets a total price of $f_i + a_i = v_H$ 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 $f_j \in (c - \bar{a}, v_H - \bar{a})$ and $a_j = \bar{a}$. Let π 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 a pair of prices f'_i, a'_i for which $f'_i + a'_i = v_H$. 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 $a_i < v_H - f'_i$, for otherwise firm i could raise a'_i slightly without reducing demand. In other words, $\mathbb{E}(f'_i + a_i | f'_i) \geq v_H$ and if $\mathbb{E}(f'_i + a_i | f'_i) > v_H$ browsing consumers do not buy and studying consumer do not buy when $f'_i + a_i > v_H$, so that firm i for positive measure of prices (f'_i, a_i) has zero sales, and hence zero profits—contradicting the fact that i earns positive equilibrium profits. Thus, $\mathbb{E}(f'_i + a_i | f'_i) = v_H$ and hence for firm i to earn positive profits some rival must set headline prices for which $\mathbb{E}(f_j + a_j | f_j) = v_H$. 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 $\hat{f}_i = v_H - \bar{a} - \eta$ for a sufficiently small $\eta > 0$, a contradiction. We conclude that all firms set total prices $f_i + a_i < v_H$ 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 $\mathbb{E}(f_i + a_i|f_i) \rightarrow \overline{\mathbb{E}}$, 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 $\overline{\mathbb{E}} = \underline{\mathbb{E}}$.

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

Auxiliary results for the proof of Proposition 3.

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 γ_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 (γ', \bar{a}) for some γ' 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 γ'_i . If $\Gamma_i(\gamma_i|\bar{a}, f'_i)$ has multiple mass points, consider those γ'_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 γ'_i and avoid the additional price \bar{a} with strictly positive probability while browsing. But since these

consumers do not observe γ_i , firm i can increase profits by shifting the probability mass away from γ'_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, γ_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 γ_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 γ_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 γ_i , and because high-value consumers never want to choose a different γ_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 η 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 η , 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 $a_i = \min\{v_H - f_i, \bar{a}\}$.

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 buy 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 η , it remains to establish that the deviant firm cannot lose 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 η . In case $f_{min} = v_L$ a browsing low-value consumer does not buy, and the firm can choose η 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 $\underline{f}_j = f_{min}$. 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 η 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 η 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 2η 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 η . 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 η 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 proba-

bility 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, γ_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 π_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 π_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 π_l .

The fact that firm h earns π_l implies that for all prices below f_{max} it earns at most π_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 π_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 η 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 η less. Similarly, firm l earns at most η 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 η , $\pi_l > \pi_i$. But firm i could deviate and set f_{min} in which case it would earn π_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 3. 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 α . 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 $\frac{\alpha}{I}(f_{max} - c)$. 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 $\frac{\alpha}{I}(f_{max} - c)$.

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

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

Substituting (2) into (3) gives

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

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

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

Observe that the left-hand side of the above equation is increasing in α , 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 α 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

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

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 α . Since all consumers purchase the product for any α , and hence the cost of production are the same independently of α it suffices to show that the firms' expected profits $\frac{\alpha}{1} (f_{max} - c)$ are increasing in α . This holds obviously for any $\alpha > \alpha^*$. It remains to show that for any $\alpha \leq \alpha^*$, f_{max} increases in α .

For these values of α , 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 α and are identical for $\alpha = 1$. But since the derivative of the left-hand side with respect to α , $\frac{-2}{\alpha(2 - \alpha)}$, is larger than the

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

Proof of Proposition 4. We look for an equilibrium of the same type as in Proposition 3 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 3, 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

$$G(f) = 1 - \frac{\alpha(f_{max} - f)}{2(1 - \alpha)(f + \bar{a}_H - c)} \quad \text{for } f \in [f_{min}, f_{max}], \quad (7)$$

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 3 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 3 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 5. First, we show that all consumers who buy must study with probability one. Towards a contradiction, suppose some consumers who buy do not study with probability one. Suppose without loss of generality that they buy from firm i with positive probability without studying. Firm i can therefore earn arbitrarily large profits by increasing a_i since consumers can only avoid paying a_i if they study, a contradiction. We conclude that (almost) all consumers who buy study with probability one.

Conversely, if a positive mass of a given consumer type studies, then (almost) all studying consumers of that type must buy. Suppose low-value consumers who study do not buy with positive probability. Then some firm i must set prices $f_i > v_L$ with positive probability. Since (almost) all consumers who buy study, firm i could strictly increase its profits by lowering f_i to v_L and set $a_i = v_H - v_L$ in which case all consumers who study pay their total willingness to pay, a contradiction. Similarly, if some high-value consumers who study do not buy, some firm i who charges $f_i + a_i > v_H$ can profitably deviate and use the above pricing strategy, a contradiction.

Finally, note that it is a best response for high-value consumers to browse and not purchase for any f_i if they believe that $f_i + a_i \geq v_H$, and hence an equilibrium in which a positive fraction of high-value consumers browse exists. \square

Proof of Proposition 6. As before, we denote by f_{min} and f_{max} the infimum and supremum of all firms' equilibrium headline-price distribution.

All consumers know the conditions $\gamma = 0$. We proceed in three steps. We show first that all consumers buy with probability one. Second, we establish that $f_{min} = f_{max}$. In the third step, we prove that $f_{min} = f_{max} = c - (1 - \alpha)\bar{a}$.

Step (i): all consumers buy with probability one. We show first that all consumers buy with probability one.

Suppose high-value consumer do not buy with probability one. Thus, at least two firms charge total prices above v_H with positive probability. Take any equilibrium price pair f_i and a_i that corresponds to a total price above v_H ; then high-value studying consumers do not buy with probability one. If browsing high-value consumers buy from the firm at the headline price f_i with positive probability, then the firm must set $a_i = \bar{a}$ conditional on charging f_i ; hence, high-value browsing consumers also do not buy at f_i . Furthermore, because $f_i + a_i > v_H$, we know that $f_i > v_H - a_i \geq v_H - \bar{a} \geq v_L$, implying that low-value consumers do not buy either at these prices. Thus, a firm charging a total price above v_H makes zero profits. But it could deviate and set $f_i = v_H - \bar{a}, a_i = \bar{a}$ in which case it sells to high-value browsing consumers whenever they see the equilibrium headline price f_j of a rival that sets a total price above v_H , and hence earn positive profits. We conclude that high-value consumers buy with probability one. This implies that firms set $a_i = \min\{\bar{a}, v_H - f_i\}$, for otherwise doing so is a profitable deviation.

Suppose low-value consumers do not buy with probability one. Hence $f_i > v_L$ with positive probability for at least two firms. We consider two cases. Case (i): all firms set the same total price $t \in (v_L, v_H)$. Because a share of ϵ of high-value consumers browse, a firm could then discretely increase demand by setting a price $f_i = t - \bar{a} - \eta, a_i = \bar{a}$ for any $\eta > 0$, which is a profitable deviation for sufficiently small η . Case (ii): the supremum of the total price distribution of all firms t_{max} is strictly greater than the infimum of the total price distribution across all firms. Then a high-value consumer who faces an equilibrium headline-price f_i that corresponds to the total price t_{max} strictly prefers to browse. Hence, if a single firm charges t_{max} with positive probability it makes zero profits while it would earn positive profits when charging $f_i = v_L - \bar{a}, a_i = \bar{a}$; and if multiple firms charge t_{max} , each of these firms has a strict incentive to deviate to a price $f_i = t_{max} - \bar{a} - \eta, a_i = \bar{a}$ for some $\eta > 0$. If no firm charges t_{max} with positive probability, then the profits of a firm attaining t_{max} goes to zero when doing so, while the profits of setting $f_i = v_L - \bar{a}, a_i = \bar{a}$ are bounded away from zero, a contradiction. So we conclude that all consumers buy with probability one. This implies that $f_i \leq v_L$ and $a_i = \bar{a}$.

Step (ii): $f_{min} = f_{max}$. Towards a contradiction, suppose that $f_{min} < f_{max}$. Clearly, $f_{max} + \alpha\bar{a} > c$.

We note first that at least two firms must attain f_{min} , since otherwise the one firm that attains f_{min} could strictly increase profits by strictly increasing the headline price in such a way that it remains the lowest headline price with probability one. Because all rivals set \bar{a} , the firm will continue to sell to all browsing consumers that see its headline price; furthermore, it continues to sell to studying low-value consumers because they can avoid the additional price by fulfilling the condition $\gamma = 0$, and it continues to sell to high-value studying consumers because the fact that all consumers buy with probability one implies that $f_{max} + \bar{a} < v_H$.

We now establish that whenever $f_{min} < f_{max}$, consumers strictly prefer browsing when they observe an initial price $f_i > f_{min}$. Since low-value consumers know $\gamma = 0$ and can avoid it without studying, they do not benefit from studying. Similarly, high-value consumers pay \bar{a} , whether they browse or study. But when browsing, both types observe a headline price $f_j \in [f_{min}, f_i)$ with strictly positive probability as at least two firms attain f_{min} . Thus, low-value and high-value consumers browse with probability one when they observe an initial price $f_i > f_{min}$.

We show next that given that all consumers browse for headline prices $f_i > f_{min}$ and given that all firms charge \bar{a} , firms face Bertrand competition, implying that $f_{min} = f_{max}$. To see this, we first rule out mass points at f_{max} when $f_{max} > f_{min}$.

If at least two firms have a mass point at f_{max} , one of these firms can strictly increase demand by shifting probability mass from f_{max} to $f_{max} - \eta$ for any $\eta > 0$. For a sufficiently small η , the difference in prices vanishes, and profits strictly increase, a contradiction. If one firm has a mass point at f_{max} , the firm earns zero profits at this headline price. By shifting the probability mass to $f_{min} + \eta$ for $\eta > 0$ sufficiently small, the firm can earn strictly positive profits instead, a contradiction. We conclude that there is no mass point at f_{max} .

When there is no mass point at f_{max} , take a firm i that attains f_{max} . Firm i sets strictly positive probability mass in the interval $(f_{max}, f_{max} - \eta_2)$ for every $\eta_2 > 0$. As η_2 goes to zero, the probability that another firm sets a smaller price converges to one. Thus, firm i 's profits converge to zero. But firm i can earn strictly positive profits by shifting probability mass to $f_{min} + \eta_3$ for $\eta_3 > 0$ sufficiently small. The same argument holds when only one firm attains f_{max} , contradicting that f_{max} is the supremum. We conclude that $f_{min} = f_{max}$.

Step (iii): $f_{min} = f_{max} = c - (1 - \alpha)\bar{a}$. Suppose towards a contradiction that $f_{min} = f_{max} > c - (1 - \alpha)\bar{a}$. By the first equilibrium-selection assumption, we know that some consumers browse. Thus, a firm can strictly increase profits by setting $f_{min} - \eta$ for a sufficiently small $\eta > 0$, a contradiction. We conclude that $f_{min} = f_{max} = c - (1 - \alpha)\bar{a}$. Low-value consumers pay only this price and high-value consumers additionally pay \bar{a} , and firms earn zero profits. \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.²¹ 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 $N - 1$.

²¹ Other histories are irrelevant for the equilibrium incentives and hence need not be specified; see Blume and Heidhues (2006).

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 .

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

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

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

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

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

$$\sum_{i=0}^{K-1} \binom{N-1}{i} (1-G(f_j))^i G(f_j)^{N-1-i} = \frac{(N-1)!}{(N-1-K)!(K-1)!} \int_0^{G(f_j)} x^{N-K-1} (1-x)^{K-1} dx. \quad (8)$$

Hence,

$$\begin{aligned} & D(f_j) \\ &= \frac{1}{2} \left[1 - \frac{(N-1)!}{(N-1-K)!(K-1)!} \left[\int_0^{G(f_j)} x^{N-K-1} (1-x)^{K-1} dx \cdot G(f_j) - \int_{f_j}^{f_{max}} g(z) \int_0^{G(z)} x^{N-K-1} (1-x)^{K-1} dx dz \right] \right] \\ &= \frac{1}{2} \left[1 - \frac{(N-1)!}{(N-1-K)!(K-1)!} \left[\int_0^{G(f_j)} x^{N-K-1} (1-x)^{K-1} dx \cdot G(f_j) - \left[G(z) \int_0^{G(z)} x^{N-K-1} (1-x)^{K-1} dx \right]_{f_j}^{f_{max}} \right. \right. \\ &\quad \left. \left. + \int_{f_j}^{f_{max}} G(z)^{N-K} (1-G(z))^{K-1} g(z) dz \right] \right] \\ &= \frac{1}{2} \left[2 - \frac{(N-1)!}{(N-1-K)!(K-1)!} \left[2 \int_0^{G(f_j)} x^{N-K-1} (1-x)^{K-1} dx \cdot G(f_j) + \int_{G(f_j)}^1 x^{N-K} (1-x)^{K-1} dx \right] \right]. \end{aligned} \quad (9)$$

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 (8) 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:

$$D'(f_j) = \frac{-g(f_j) \cdot (N-1)!}{2(N-1-K)!(K-1)!} \left[G(f_j)^{N-K} (1-G(f_j))^{K-1} + 2 \int_0^{G(f_j)} x^{N-K-1} (1-x)^{K-1} dx \right]. \quad (10)$$

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

$$\pi(f_j) = \pi(f_{max}), \quad \forall f_j \in [f_{min}, f_{max}], \quad (11)$$

which implies that

$$D(f_j) = \frac{\alpha}{2(1 - \alpha)} \cdot \frac{f_{max} - f_j}{f_j + \bar{a} - c}, \quad \forall f_j \in (f_{min}, f_{max}). \quad (12)$$

We now construct the headline price distribution $G(\cdot)$ on $f_j \in (f_{min}, f_{max})$ that satisfies (12). Differentiating (12) 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 (10) and rearranging, gives

$$g(f_j) = \quad (13)$$

$$\frac{(N - 1 - K)!(K - 1)!}{(N - 1)!} \left[G(f_j)^{N-K} (1 - G(f_j))^{K-1} + 2 \int_0^{G(f_j)} x^{N-K-1} (1 - x)^{K-1} dx \right]^{-1} \left[\frac{\alpha}{(1 - \alpha)} \cdot \frac{f_{max} + \bar{a} - c}{(f_j + \bar{a} - c)^2} \right]. \quad (14)$$

The right-hand side is continuous and strictly positive on the interval (f_{min}, f_{max}) . Since additionally (12) 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. (12), implies that $D(f_j)$ is strictly increasing in f_{max} . By (9), 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 (12) implies that $D(f_j = f_{max} - s)$ is strictly decreasing in f_{max} for any given headline price difference s . By (9), 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 (11) 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 (13), 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 (13) has strictly positive limit as $f_{max} \rightarrow \infty$. For any given $s > 0$, the second term in squared brackets of (13) 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 (12) is continuous in $G(f_j)$, c , \bar{a} , α , f_{min} , and f_{max} , and since Γ 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 Γ , 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 α 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 $\frac{\partial E(f_j)}{\partial \bar{a}} < 0$. □

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

$$D(f_j) = \frac{\alpha}{2(1-\alpha)} \cdot \frac{f_{max} - f_j}{f_j + \bar{a} - c}, \quad \forall f_j \in (f_{min}, f_{max}), \quad (15)$$

which is identical to (12) 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, the 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 an 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 π . 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 π for almost all prices in the support. \square

Proof of Proposition 9. 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 α . 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 f_3 to a marginally larger headline price. But then an incumbent can increase demand by shifting probability mass from $(f_3, f_3 + \eta)$ to $f_3 - \eta/2$ 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 η , 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 $\check{f} - \eta/2$ 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 η 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 3, 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 α . For these α , 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 α at any price in the support. Using the same algebra as in the proof of Proposition 3, 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 α and approaches zero as α approaches 1. Thus, we conclude that if $f_{max} < v_L$, f_{max} strictly increases in α .

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 α . Then firms set the largest possible price $f_{max} = v_L$ for large enough α , 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 α , 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 10. In the proof of Proposition 3 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 3 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 3 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. α as $f_{max} = E[f] + \bar{a}$, implying that expected prices that consumers pay increase in α also when $s_3 < \bar{a}$. \square

Proof of Proposition 11. Denote the share of high-value consumers that become more informed by λ ; 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 3 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 3 and strictly above c . For any pair of f_{cap}, λ 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 3.

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 α 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 3 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 3 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 α . 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 3 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 λ 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

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

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

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

Substituting Equation 21 into the above equation yields

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

Observe that the numerator of the fraction of integrals in the above expression is positive and bounded away from zero for any α , 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 α , 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 α' , 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 $\frac{d\pi}{df_{cap}} \Big|_{\lambda=1}$ shows that the derivative of the profit function is negative for $\alpha < 0.365$.) Hence, for such α , introducing a binding price cap increase equilibrium profits and, thus, makes consumers worse off.

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

Proof of Proposition 12. 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 α . 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 . \square