Browsing versus Studying Offers*

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June 15, 2017

Abstract

We introduce a simple model of a market in which consumers must make tradeoffs between "browsing" more products superficially, and "studying" fewer products in detail. Each firm chooses two price components, a headline price and an additional price, and specifies conditions under which a consumer can avoid the additional price. Each consumer can either fully understand the offer of one firm (studying), or look at only the headline prices of two firms (browsing). In equilibrium, high-value consumers browse and pay the additional price, but low-value consumers study to avoid the additional price. Although high-value consumers pay higher total prices, the average price consumers pay is *decreasing* in the share of high-value consumers. This result is consistent with evidence that a number of essential products are more expensive in lower-income neighborhoods, and our model also helps explain why entry into such neighborhoods does not solve the problem. More importantly, our framework generates a novel and powerful competition-policy-based argument for regulating the additional price or other secondary product features. In contrast to existing arguments that such regulations may be ineffective or even distortionary, we show that they have a multiplier effect: because consumers do not need to worry about the regulated feature, they do more browsing, enhancing competition. In many situations, the increase in competition also increases efficiency, but we identify a class of situations in which there is a tradeoff between competition and efficiency.

*We thank Mark Armstrong, Bard Harstad, Alex Imas, Daniel Krähmer, Alexander Morell, Gautam Rao, Antonio Rosato, and seminar audiences for useful comments.

1 Introduction

When shopping for today's complex or complexly priced products, consumers with limited cognitive capacity must decide how well to understand each product on offer, knowing that a deeper understanding will require more effort. Consumers then face a basic, yet in economics unexplored, dilemma: whether to *browse* more products superficially, or *study* fewer products in detail. A consumer looking for a mobile plan, for instance, may spend a little bit of effort to find out an offer's basic features (such as the monthly fee and number of included minutes), or more effort to also understand the contract's precise conditions, additional fees, and potential traps. But if she does the latter, then she is left with less time and energy to look for competitors' offers, or to search for good deals in other areas of life.

In this paper, we identify several economically important implications of the above dilemma for the performance and regulation of markets. Because in some situations high-value consumers engage in competition-enhancing browsing while low-value consumers study to obtain lower prices at individual sellers, the average price consumers pay may be *decreasing* in the share of high-value consumers. This result is consistent with evidence that a number of essential products are more expensive in lower-income neighborhoods, and our model also helps explain why entry into such neighborhoods does not solve the problem. More importantly, we identify a competition-policy-based argument for 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—that take effort for consumers to understand. Because consumers do not need to worry about the regulated feature, they do more browsing, enhancing competition. In many situations, the increase in competition also increases efficiency, but we identify a class of situations in which there is a tradeoff between competition and efficiency.

We present our basic model in Section 2. We assume that each firm charges two price components, an unrestricted headline price and a capped additional price, and specifies conditions under which a consumer can avoid the additional price. To isolate the tradeoff between browsing and studying in the sharpest possible way, we posit that a consumer can either study the full offer of one firm—thereby learning its additional price and how to avoid it—or look at only the headline prices of two firms—thereby failing to learn how to avoid the chosen firm's additional price. Low-value consumers find it costless to fulfill a firm's conditions for avoiding the additional prices, while high-value consumers find fulfilling most conditions too hard. Within their attentional constraints, consumers choose their search strategies optimally.

We argue that—potentially with modifications that (we show) do not affect the main insights—our model captures the essential features of a variety of markets for complex products. In particular, the two price components may be the monthly fee and overage charges of a mobile phone, the annual fee and interest rate of a credit card, or the sale price and non-sale premium of a supermarket.

We study the positive implications of our model in Section 3. In equilibrium, firms charge the maximum additional price. Since high-value consumers prefer not to avoid the additional price, they have a dominant strategy of browsing. More subtlely, we show that in equilibrium low-value consumers can always save more money by studying. 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.

The prediction that the average price is increasing in the share of low-value consumers provides a potential explanation for the finding that consumers in lower-income neighborhoods pay higher prices for various goods and services, including mortgages, groceries, and cars (Fellowes, 2006, Agarwal et al., 2016). 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).

One might hope that if selling products in lower-income neighborhoods is so profitable, then more firms will enter and generate lower prices for consumers after all. We investigate this possibility under the realistic assumption that a new entrant is in a disadvantageous position when trying to attract the limited attention of consumers. We 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.

In Section 4, we turn to the economically most far-reaching implications of our model: those concerning the regulation of product prices and features. To make a basic version of our point, we think of the cap on the additional price as a regulatory cap, and in Section 4.1 ask what happens without the cap. We show that consumers must then study to make sure firms are not price gouging, making each firm a local monopolist. As a potential example, Bar-Gill (2008) 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. Regulation of the additional price can therefore be essential for generating competition in a market.

A similar logic applies to a completely different intervention, a kind of opt-in regulation. 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 opt in, 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. Under this 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.

We show that the competition-enhancing effect of regulation is robust to variants of our model. In Section 4.2, we study products for which consumers cannot avoid the additional price. This assumption applies, for instance, to the price and energy efficiency of a product, or to the wage and working conditions of a job. As a simple case, suppose that consumers are homogeneous, and consider a cap above firms' equilibrium additional price. In a classical model, such a price regulation would be irrelevant both because it is not binding, and because it does not restrict the total price firms can charge. In our case, however, the cap turns firms from local monopolists to perfect competitors.

We also consider situations in which neither price component is exogenously more salient than the other, assuming that each consumer can check two price components of her choice, and that both components are capped. Then, a natural equilibrium arises in which a firm's two prices are random, on average high, and negatively correlated. We argue that this equilibrium is broadly consistent with basic facts about the Mexican market for retirement financing documented by Duarte and Hastings (2012). Regulations once again can have direct *and* indirect positive effects. A decrease in the cap lowers not only prices that were previously above the cap, but shifts the distribution of prices down even below it. The effect of regulating one component of the price at a low level is even more drastic. While a common argument against such regulation is that firms will compensate by raising other components of the price, in our setting the other price component often drops as well.

In Section 4.3, we 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 heterogenous tastes for the basic versions of the products. In contrast, if a consumer needs to study to determine whether she likes the basic or premium version of the product, then regulation enhances competition at the cost of lowering efficiency.

In Section 5, 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 6 by identifying some alternative motives for studying that partially qualify our positive and normative points.

2 Basic Model

2.1 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 $a_i \in [0, \overline{a}]$, and a condition $\gamma_i \in [0,1]$ that consumers must fulfill to avoid the additional price. Consumers are looking to buy at most one product. If a consumer purchases product i, she pays f_i. In addition, she chooses a usage pattern $\tilde{\gamma} \in [0,1]$, and pays a_i if 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 $\overline{a}$; this means that her utility from purchasing product i is $v_L - f_i - \mathbb{I}(\tilde{\gamma} \neq \gamma_i)a_i - \mathbb{I}(\tilde{\gamma} \neq \gamma^*)k$, with $k > \overline{a}$. We suppose that $v_H \geq v_L + \overline{a}$, so that high-value consumers get a weakly higher consumption benefit from any contract offer. The share of low-value consumers is $\alpha \in (0,1)$.

The key innovation in our model concerns how consumers can search the products. 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 up-front price. A consumer assigned to firm i can then learn exactly one more thing: either the additional price a_i and condition γ_i of firm i—which we refer to as "studying"—or the headline price f_j of a rival j selected randomly and with equal probability from the other firms—which we refer to as "browsing."[1] A consumer can only buy from a firm if

[1] 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

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 $F_i(\cdot)$ 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 $f_i \in \mathbb{R}, a_i \in [0, \overline{a}]$. A firm's equilibrium triplet maximizes expected profits given the behavior of consumers and competitors. A consumer's beliefs are derived from firms' equilibrium strategies using Bayes' Rule whenever possible, and the consumer's strategy maximizes expected utility at each information set.

Furthermore, we impose two mild equilibrium-selection assumptions. First, we posit that some high-value consumers—for whom studying is a weakly dominated strategy—browse. This assumption allows us to rule out Diamond-paradox-type equilibria in which all firms set $v_L, \overline{a}$ and all consumers study. 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.[2]

2.2 Alternative Modeling Assumptions

In many applications, there are alternative assumptions that are as plausible as those we have made. We briefly outline some possibilities that—as we will argue or formally show—do not affect the fundamental mechanism of our model based on the tradeoff between browsing and studying.

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.

[2] Our second equilibrium-selection assumption is closely related to the notion of wary beliefs proposed by McAfee and Schwartz (1994) and used in a context similar to ours by Armstrong (2015), whereby consumers suppose that also for out-of-equilibrium headline prices firms choose optimal additional prices. As our proof makes clear, in our setting these beliefs coincide with what McAfee and Schwartz term passive beliefs.

Consumer Understanding. We have assumed that consumers are rational, but we believe that consumer naivete is important in most of the markets we discuss. One way in which consumer naivete can manifest itself is that consumers study the product and attempt to avoid the additional price, but fail to do so. For example, a borrower may spend a lot of time attempting to understand her unconventional mortgage contract and believe that she will avoid traps, yet still be deceived by the contract. So long as these naive consumers understand that they need to worry about the additional price, the logic of our model remains unchanged.

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. In some settings, the opposite is the case. For instance, a high-income consumer may never have trouble repaying her credit-card balance, and hence never pay interest or late fees. This possibility only strengthens our qualitative results.

Breadth of Tradeoff between Browsing and Studying. Finally, our model focuses on a single product market, and by implication models the tradeoff between browsing and studying at the product level. In reality, the tradeoff is likely to be even more important at a broader level: if a consumer needs to study many of her products, she has less attention left to comparison shop in general. Even then, the mechanism behind our results seems operational.

2.3 Applications

We briefly describe possible applications of our formal model.

Application I: Mobile Phones and Other Products with Add-Ons. For mobile phones, f_i could be the monthly fee, a_i the additional charges for roaming, extra minutes or data, or other services, and γ_i 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 the phone. The cap $\overline{a}$ 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 are willing to use.

Application II: Credit Cards, Bank Accounts, Mortgages, and Other Financial Products. Our model also applies to complex financial products. For credit cards, we can think of f_i as the annual fee and of a_i as interest and other fees, with γ_i describing when the latter fees are not charged. Similarly, for bank accounts f_i could be the account maintenance fee and a_i the overdraft or other fee, with the γ_i describing when overdraft fees are not triggered. In the case of mortgage contracts, f_i could be the initial monthly payment, a_i the change in payments at the mortgage's potential reset date, and γ_i the conditions under which a large change in payments can be avoided. In these applications, it is plausible to assume that (as discussed above) high-value consumers avoid the additional price without studying the offer. Once again, the cap $\overline{a}$ could come from regulation or the threat of regulation.

Application III: Supermarkets. In the case of supermarkets, f_i can correspond to the price a consumer pays if she takes advantage of discounts and sales, a_i to the amount of savings that are available, and γ_i to the way in which these savings can be obtained. Getting the discounts entails distorting one's consumption choices to buy the items that happen to be on sale, or distorting one's shopping patterns to visit the store when the right items are on sale. Low-value consumers find it worthwhile to adjust their shopping to obtain discounts they know about. High-value consumers, in contrast, are unwilling to give up their habitual shopping patterns or preferred brands for such savings. Because there is no—existing or realistic—legal constraint on the value of supermarket sales, in this application it is implausible to assume that the cap $\overline{a}$ derives from regulation. Instead, the additional price might be restricted due to an "outrage constraint:" that consumers encountering overly high prices relative to the sale prices would be unwilling to buy. Alternatively, it is also plausible to assume that a_i is fixed at $\overline{a}$ for exogenous reasons, for instance by the manufacturer.[3]

[3] Our model assumes that a browsing consumer observes f_i and not $f_i + a_i$ before her purchase decision. This assumption may describe consumers who choose a supermarket based on advertised sale prices. Browsing consumers, however, may want to and be able to choose between supermarkets based on shelf prices. When a_i is exogenously fixed, observing f_i and $f_i + a_i$ are equivalent, and the equilibrium we characterize below survives.

3 On High Prices in Low-Income Neighborhoods

3.1 Main Result

The equilibrium has the following structure:

Proposition 1. *In equilibrium, all firms charge an additional price of $\overline{a}$. Low-value consumers study and avoid paying the additional price, while high-value consumers browse and incur the additional price. 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 $f_{max} = E[f] + \overline{a} < v_L$ for $\alpha < \alpha^*$. The expected price that consumers pay is increasing in α.*

To take advantage of browsing consumers, firm i optimally sets $a_i = \overline{a}$ and randomizes γ_i so that there is no chance of guessing it. Hence, a consumer can only avoid a_i by studying. Since high-value consumers prefer not to avoid the additional price, they have a dominant strategy of browsing. Less obviously, in equilibrium low-value consumers can always save more money by studying. Since all firms set $a_i = \overline{a}$, a consumer prefers to browse if and only if the headline price it observes is sufficiently high. Now consider the firm that charges the highest equilibrium headline price, supposing for illustration that no other firm charges the same price with positive probability. If at this price low-value consumers preferred to browse, then the firm would lose all consumers to lower-priced competitors with probability one. As a result, the firm prefers to lower 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 important 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 there is a direct positive effect of high-value consumers on prices paid. On the other hand, high-value consumers have an indirect negative effect on the prices firms charge because their browsing spurs competition. Proposition 1 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, an additional effect comes into play. Again similarly to Varian, because high-value consumers are responsive to the up-front price, in competing for these consumers firms select a random up-front price. When there are many high-value consumers, the competition is intense, so that the expected headline price of firms 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. In an effect reminiscent of the "competition for consumer inattention" in De Clippel et al. (2014), this threat of losing low-value consumers reduces the price determining the profit base to below v_L.

The main prediction of Proposition 1 provides a potential explanation for evidence that consumers in lower-income neighborhoods pay higher prices for various goods and services, including groceries, mortgages, and cars (Fellowes, 2006, Agarwal et al., 2016).[4] Strengthening the plausibility of our explanation is some evidence consistent with the mechanism of our model based on the tradeoff between browsing and studying. 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, Agarwal et al., 2016). Yet lower-income consumers obtain lower prices at the stores they do frequent. In particular, 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.

Beyond the cross-sectional prediction comparing high-income and low-income populations, our model also has an intriguing prediction regarding a developing society. As a society gets richer and thereby increases the share of high-value consumers, the market shifts toward more competitive pricing, while at the same time firms derive a greater part of their profits from additional prices. Unfortunately, we are not aware of clear evidence on this prediction.

[4] There is, however, also evidence pointing in the other direction. Most importantly, Broda et al. (2009) find that consumers in low-income neighborhoods pay less for groceries than consumers in high-income neighborhoods, mainly by shopping at supercenters outside their neighborhoods. We discuss this in more detail at the end of the subsection.

The above main prediction is robust to several alternative specifications of our model. Suppose first that—as in the case of credit-card interest or bank overdraft fees—high-value but not low-value consumers avoid all or part of the additional price without studying. We capture this by positing that the additional price a consumer pays if she fails to fulfill the firm's conditions is heterogenous: it is $\overline{a}_H \geq 0$ for high-value consumers and $\overline{a}_L > 0$ for low-value consumers.[5] We show that the equilibrium characterized in Proposition 1 survives qualitatively unchanged, and in fact features an interesting comparative static:

Proposition 2. *The average total price consumers pay is decreasing $\overline{a}_H$, and increasing in $\overline{a}_L$.*

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 ex post on consumers are competed away ex ante in an effort to attract consumers. In our model, the profits firms make on high-value consumers are *more than* competed away because the competition for profitable high-value consumers increases the threat of low-value consumers browsing, inducing firms to lower prices further. In contrast, the average total price is increasing in the additional price low-value consumers would pay—even though low-value consumers do not pay it. A higher additional price lowers low-value consumers' incentive to browse, which in turn lowers firms' incentive to keep prices depressed.

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

[5] We continue to assume that the cost of high-value consumers to satisfy almost any condition is greater than $\overline{a}_H$ and that $v_L + \overline{a}_H \leq v_H$.

leaves the equilibrium prices completely unchanged:

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

While the profits firms make ex post from high-value consumers are more than competed away, the profits they make from unexpected payments by 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.

Going slightly beyond our model, Proposition 2 and Corollary 1 have an interesting implication regarding the origin of additional prices. As argued by Heidhues et al. (2016), additional prices are usually not fundamental features of the product, but result from "exploitative innovations" by firms trying to increase profits. If so, our results suggest that firms aim to invent additional prices that apply disproportionately to low-value consumers rather than high-value consumers. If low-value consumers are also naive, this has adverse distributional implications.

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.

Finally, it is worth emphasizing again that the tradeoff between browsing and studying may occur not at the product level, but at a broader shopping level. In particular, it may be the case that for some products, a consumer can both browse and study, obtaining especially low prices. This may, however, leave her with little time to contemplate her other purchases, leaving her especially badly off in these other domains. Consider the often discussed example of food. As we have mentioned above, there is evidence that—consistent with our model—food prices are higher in lower-income than higher-income neighborhoods. But some researchers have also found that—in contrast to our model—consumers in lower-income neighborhoods pay less for food, primarily because they shop more at supercenters outside their neighborhoods (Broda et al., 2009). One interpretation of this behavior is that consumers are engaging in especially costly effort to obtain discounts: the high prices in their neighborhood force them to go the extra mile for lower-priced deals. If so, that might mean that they pay less for food, but have even less time and energy to find deals in other areas of life (e.g., financial decisions). This perspective is roughly consistent with Mullainathan and Shafir's (2013) view that low-income consumers focus on some aspects of their financial lives at the—very costly—expense of ignoring crucial others.

3.2 Entry

We analyze a model of how entry interacts with the search issues at the heart of our paper. A reassuring thought might be that since opening up shop for a population with a high proportion of low-value consumers 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 with limited attention. Furthermore, it seems natural to assume that a new entrant is in a disadvantageous position in such a search.

We model the above situation 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 above, 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 3. *In equilibrium, all firms charge an additional price of $\overline{a}$. Low-value consumers study and avoid paying the additional price, while high-value consumers browse and incur the ad-*

ditional 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* $[f_{min}, \overline{f}_3]$*, where* $f_{min} < \overline{f}_3 < f_{max}$*. Firms 1 and 2 earn expected profits of* $\frac{\alpha}{2}(f_{max} - c)$*, and firm 3 earns an expected profit of* $\frac{(1-\alpha)\alpha}{(3-\alpha)}(f_{max} + \overline{a} - c)$*. 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 3 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 3 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.[6,7]

4 Policy

We demonstrate through analyzing a variety of policies an important economic point: that regulation can lead consumers to substitute their search effort toward browsing, enhancing competition.

4.1 Basic Policy Multiplier

To make our basic point, we consider what happens if there is no cap $\overline{a}$ on the additional price. 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 notion is consistent with most of our applications, as regulations can serve to control the additional fees imposed for bank accounts, credit cards, investments, and other services, the safety or other risks of a physical product, and the health impact or working conditions of a job. Our analysis, however, does not easily apply to our model of supermarket pricing: even in an unregulated market, a supermarket subject to price-posting laws cannot charge an additional price after purchase.[8]

Formally, we modify the model of Section 2.1 in three ways. First, crucially, we assume that there is no cap on the additional price. Second, in the absence of a cap we do not impose the

[6] 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.

[7] 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.

[8] One might imagine that in the case of supermarkets, an unregulated market is one where even price-posting laws do not apply, and prices must be bargained on an individual-by-individual basis. The bargaining necessary to obtain reasonable prices in such markets might have a similar effect as studying in our model, as it takes time and energy away from other search activities. We have, however, not explored the full formal relationship with our model.

equilibrium-selection assumption that some high-value consumers browse.[9] Third, for simplicity we assume that high-value consumers cannot avoid the additional price at any cost. Then, the equilibrium looks completely different:

Proposition 4. *In equilibrium, almost all consumers who buy study. And in any equilibrium in which both consumer types buy with positive probability, firms charge* $f_i = v_L$ *and* $a_i = v_H - v_L$*.*

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—the two types of consumers. 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.

A plausible example of an insufficiently regulated market in the spirit of Proposition 4 is the subprime mortgage market, at least before new regulations took effect in the wake of the financial crisis. Bar-Gill (2008) argues that the complexity of the fees lenders could impose rendered it so difficult to compare products that borrowers may have even rationally decided not to do any comparison shopping. As a result, and despite the seemingly competitive nature of the market by conventional measures of concentration, lenders may have acted as virtual monopolies vis-a-vis borrowers.

The point that market intervention can act through empowering consumer search applies to policies beyond the direct regulation of the additional price. As a potentially important example, we consider a type of "opt-in" policy when there is also a cap $\overline{a}$ on the additional price. Suppose that the social planner imposes a known default of $\gamma_i = 0$; 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. For instance, the government can design a standard mortgage contract with simple fees, and the consumer can refuse to consider other (potentially more complicated) offers without reading them. Holding prices and search behavior fixed, this does not affect any outcomes—low-value consumers avoid the additional price, while high-value

[9] With the cap on the additional price, studying is weakly dominated for high-value consumers, making the equilibrium-selection assumption reasonable. Without a cap, studying is no longer weakly dominated, undermining the case for the assumption.

consumers do not—and hence can be considered a nudge. The policy, however, does have a drastic effect:

Proposition 5. *With an opt-in policy, low-value and high-value consumers pay total prices of* $c - (1-\alpha)\overline{a}$ *and* $c + \alpha\overline{a}$*, respectively, and firms make zero expected profits.*

Low-value consumers can now not opt in and—no longer needing to study to avoid the additional price—browse, inducing perfect competition between firms. This means that in two senses, the opt-in 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 total price consumers pay is increasing in the share of low-value consumers. With regulation, it is constant.

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 3.1). 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 naive consumers who aware of the additional price better avoid the additional price, then it helps these consumers, but by Corollary 1 it does not otherwise effect market outcomes.[10]

The broad message that emerges from these insights is a powerful competition-policy-based argument for regulating 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 of course contrasts with the common presumption that restrictions on what

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

people can trade—especially restrictions on contracts—create deadweight loss. But the view has some precedent in development economics. Duflo (2012) makes the case most powerfully: she argues that while regulation is often thought to reduce freedom by preventing trades people might want to make, 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.

The above message also contrasts sharply with a common argument against consumer protection and other interventions aimed at improving individuals' decisions and welfare. The argument can be summarized as the "nanny-state" concern: 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, 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).[11] Our results say that the opposite may well be the case: policies can enhance consumer welfare not only through their direct effect of preventing mistakes, but by their indirect effect of liberating consumers to search more, in the process enhancing competition as well. Consumer protection thereby has a beneficial multiplier effect.

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.

[11] 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).

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—with ambiguities resolved in favor of the consumer—and that are too disadvantageous to the consumer. The EU applies similar principles.[12] Our model says that such legal principles are not only a matter of ensuring fairness—which is how the principles are couched—but a matter of facilitating competition.

Second, the message that regulation of additional prices or other secondary features can have a substantial pro-competitive effect must of course be balanced against classical concerns regarding regulation. For instance, these 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 the possible distortions from regulation, and citizens' limited attention to policies, are explicitly specified. Such a framework is beyond the scope of this paper.

4.2 When Consumers Cannot Avoid the Additional Price

So far, we have assumed that consumers can avoid the additional price. We consider the robustness of our policy results to this assumption. We suppose throughout the subsection that a consumer who buys from firm i must pay both f_i and a_i. For simplicity, we also assume that all consumers value the product at v_H. We consider two cases.

4.2.1 Markets with Headline Price

First, we keep all other assumptions of our basic model unchanged. In the labor market, for instance, we can think of the wage as the headline price and of the working conditions—such as job safety—as the additional price, both of which affect all workers. And in the case of electric appliances, the purchase price could correspond to the headline price and energy efficiency to the additional price, both of which all consumers care about.

[12] 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.

If anything, the effect of imposing a cap on the additional price is even greater in this model than in the previous one:

Proposition 6. *In any equilibrium without regulation, a consumer can only buy at her value. In the unique symmetric equilibrium with regulation, all consumers buy at cost.*

To illustrate Proposition 6 in the starkest possible terms, consider an equilibrium without regulation in which all firms charge prices f, a. Now we impose a price cap of $\overline{a} > a$. In a classical setting in which consumers observe all characteristics of a searched product, this price cap would be ineffective both because it is not binding and because (independently of whether it is binding) 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.

The competition-inducing effect of regulation arises from two mechanisms. First, as above, regulation redirects consumers' search from studying to browsing. In equilibrium, consumers know that the additional price is at the maximum level, so—not needing to study—they browse, inducing competition between firms.

Second, regulation can make even a fixed search behavior more effective in selecting between products, thereby also inducing competition between firms. In an unregulated market, a cut in the headline price is essentially meaningless for a consumer not observing the additional price, because any cut in the headline price can be undone by an increase in the additional price. In a regulated market, however, there are cuts in the headline price that cannot be fully undone, so that the headline price becomes a useful signal of the total price.

To clarify the above intuition and to isolate the second mechanism from the first, we consider a simple modification of our model with exogenously fixed search. We suppose that consumers observe the headline prices of all products, but not the additional prices. There is a usury limit $\overline{v} > c$ on the total price. Then:

Proposition 7. *Without regulation, consumers do not buy if $\overline{v} > v$, and buy at a total price of $\overline{v}$ if $\overline{v} \leq v$. With regulation, consumers buy at a total price of c.*

4.2.2 Markets with No Headline Price

We now analyze products for which there is no exogenous headline price that consumers necessarily encounter first. We consider a model with two firms. A consumer—rather than automatically seeing f_1 or f_2 and choosing one additional price to learn—observes two of the four prices of her choice. Both prices are capped, with $\overline{a} = \overline{f} \geq c/2$. Furthermore, there is consumer heterogeneity: half of the consumers put higher weight on f than on a, and half put higher weight on a than on f.[13] To ensure that consumers buy in equilibrium, we assume that consumers are willing to buy at the price vector $(c + \overline{f})/2, (c + \overline{f})/2$.

The main motivation for this variant of our model is mutual or retirement funds that charge multiple fees. As a specific example, consider the Mexican market for retirement financing, as described by Duarte and Hastings (2012). Investment strategies—being heavily regulated—are quite similar between funds, but each fund can choose its own prices: a front load levied once on new funds deposited in the account and a balance fee levied every year on the full balance. A consumer should put higher weight on the balance fee if she expects to participate in the system for longer.

We construct an equilibrium in which no price component is more salient than the other, and the prices play a symmetric role:[14]

Proposition 8 (A variant of Bachi and Spiegler (2015), Proposition 2(i))**.** *In any symmetric equilibrium in which f_i and a_i have the same marginal distribution, that distribution is uniform on $[c/2, \overline{f}]$, and f_i and a_i are perfectly negatively correlated. Consumers choose the product that is cheaper on the dimension they care about more.*

In this equilibrium, a consumer checks and chooses according to the price she cares about more. When setting a price, therefore, a firm balances its desire to attract consumers who care about that price, and to take advantage of consumers who do not. As a result, there is some competition

[13] It is worth noting that the equilibrium we identify below remains an equilibrium if consumers put identical weights on the two prices.

[14] The equilibrium in Proposition 8 closely resembles that of Proposition 2(i) in Bachi and Spiegler (2015). One difference between the models is that Bachi and Spiegler impose consumers' strategies exogenously, whereas we assume that consumers choose these optimally.

in each price, but that competition is limited, resulting in random and on average high prices. Furthermore, the prices are negatively correlated: if a firm attracts more consumers with a lower f_i, then it has an incentive to take advantage of these consumers with a higher a_i, and vice versa.[15]

The above equilibrium is broadly consistent with basic facts about the Mexican market for retirement financing documented by Duarte and Hastings (2012). Despite a large number of firms selling essentially homogenous products, the fees were high and heterogeneous across firms. Furthermore, based on Table II of the paper, the front load and balance fee were negatively correlated across firms.

As in our previous models, regulations can drastically improve market outcomes. One important point is already implied by Proposition 8. A reduction in the cap on the two price components ($\overline{f}$) lowers not only prices that were above the new cap, but also prices that were lower than the new cap. Intuitively, with the price distribution at the top squeezed together, firms can attract consumers with a smaller price cut, inducing them to lower prices. This leads to more competition at even lower prices, trickling through the entire distribution.

To conclude this section, we consider one more specific kind of regulation. Suppose regulation requires that a must equal A, thereby standardizing all but one price dimension. Then, we get perfect competition:

Proposition 9. *In the unique equilibrium with price regulation,* $f_i = c - A$.

A common argument against regulating one component of firms' prices is that firms will compensate by raising other components of the price, thereby passing on the costs to consumers. While this logic makes sense in a classical model, it is incorrect in ours. For instance, suppose that $A = c/2$, so that the regulation mandates the additional price to be at the lowest point of its previously observed range. Instead of increasing, the other component of the price then *also* drops to $c/2$, the lowest point on its support. The logic is familiar: by regulating a, the government redirects consumer search toward f, creating perfect competition in that price.

[15] In equilibrium, consumers who put more weight on f must be searching f. This is necessary not for choosing the product that yields higher utility—since a is perfectly informative of f, they could search a instead—but to create the right incentives for firms. If consumers who care about f searched a, they would choose the *higher-priced* firm on that dimension, undermining the logic of equilibrium described above.

4.3 Competitiveness versus Efficiency

Our results on policy identify the effect of regulation on the *competitiveness* of the market in models where all consumers always participate, and hence efficiency is not affected. 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 Proposition 6 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 $v + \overline{a}$, each with positive probability. Producing the basic product costs zero, and producing the premium product costs c. We assume $\overline{a} > c$, so that the premium product is efficient for consumers who value it. Each consumer is initially assigned to one firm, with each firm getting 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 10. *Marginal-cost pricing is not an equilibrium. There exists an equilibrium in which $f_i = v$ and $a_i = \overline{a}$ 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.

5 Related Literature

In this section, we discuss the relationship of our paper to previous theoretical research. While we point out other differences below, no previous paper has studied the tradeoff between browsing and studying and the resulting implications for firm pricing and regulation. Accordingly, the main insights are largely distant from ours.

5.1 Search

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.[16] A few researchers have modified these assumptions, but always one

[16] For models of non-sequential search, see for instance Burdett and Judd (1983), Salop and Stiglitz (1977), and Varian (1980), and for models of sequential search, see for instance Carlson and McAfee (1984), Lippman and McCall

at a time. Replacing (iii) in the context of sequential search models, researchers have started to investigate directed consumer search (Haan et al., 2015, Armstrong, 2016). The novelty is that consumers do not choose the next firm they search randomly, but are influenced by advertisements, prior information on product value, and so on. Replacing (ii), Carlin and Ederer (2012) study the implications of convex search costs to investigate search fatigue. And replacing (i), Gamp (2015) considers consumers who can purchase a product without knowing its price. We modify all three of these assumptions.

A part of the consumer-search literature, such as Fershtman and Fishman (1994) and Armstrong et al. (2009), studies how the pricing of firms interacts with the decision of consumers to become informed. Uninformed consumers observe only the price of one firm, but can incur a cost to become informed about the prices of other firms. With sufficient consumer heterogeneity in these costs, equilibria involve informed and uninformed consumers. A price cap shrinks price dispersion and thereby reduces consumers' incentive to become informed. As a result, relatively high price caps can increase average prices and harm consumers. Our framework has exactly the opposite implication for policy.

Armstrong (2015, Section 3.1) investigates a model in which firms charge (what we refer to as) headline and additional prices. Some consumers see all prices, and some only the headline prices. Armstrong shows that relative to the case in which all consumers are informed or uninformed, having a positive fraction of rational uninformed consumers reduces price competition: a lower headline price expands market share and lowers markups, reducing the incentive to compete for fully informed consumers through a lower additional price, and hence signaling a higher additional price. The negative correlation between price components in Proposition 8 exploits the same economic force.

5.2 Bounded Rationality

Our paper is related to the literature on rational inattention in that consumers make strategic decisions on what aspects of their environment to allocate attention to. That people make such

(1976), Reinganum (1979), and Stahl (1989).

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.[17]

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. Roesler (2015) studies a monopolist selling to a consumer who chooses how to learn about the value of the product. The consumer chooses the information structure, keeping in mind 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 Krähmer (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.[18] Most closely related to our model, De Clippel et al. (2014) study a different form of competition with strategically inattentive consumers. 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 *across markets*. An increase in consumers' capacity to inspect markets—and hence a decrease in the number of uninspected markets—leads to more intense competition and lower prices. In our setting, there is only one market, but the total number of competitors the consumer checks out (0 or 1) is endogenous rather than exogenously given. As a result, consumers' tradeoff between studying and browsing can induce competition for inattention in a *single market*.[19]

[17] 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.

[18] The increase in competition resulting from the reduction in search frictions reduces the profit from offering a high-quality product, leading firms to focus their business model on exploiting naive consumers. Regulations, such as a price floor, that increase high-quality firms' profits can increase their share in the population of firms, and induce naive consumers to—by chance—more often consume a high-quality product, increasing welfare.

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

5.3 Regulation

Some previous papers have discussed indirect ways in which regulation can increase efficiency. Shleifer (2011) singles out especially contract regulations, emphasizing that from a classical perspective contracts are a substitute for regulation (e.g., for dealing with externalities), and hence should not be regulated. He argues that litigation does not seem to resolve disputes well and is rather "expensive, unpredictable, or biased," rendering regulation the more efficient alternative. We identify a completely different way in which contract regulations improve markets.

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.

6 Conclusion

While our stylized models apply to many economic situations, there are related models that generate different motives for studying and that thereby qualify some of our positive or normative conclusions. Although we have not analyzed most other possibilities formally, our insight that low-income consumers study more—and hence prices are increasing in the share of low-income consumers—should extend to many but not all alternative motives for studying; and our insight that regulatory policy can be pro-competitive should extend to any situation in which policy can lower the need to study, although it may be difficult or undesirable for a policy to do so. A consumer may study because she does not know the additional price, and she needs to learn it to decide whether the product is even worth buying. In this case, high-income consumers who are sure to buy for any price are less likely to study, and regulations reducing the uncertainty in the additional price are pro-competitive. A consumer may study because she is not sure how unscrupulous the firm is in setting additional prices. Then, low-income and high-income consumers may both have incentives to study, and regulation of firms' practices can be effective in reducing consumers' inclination to study. A consumer, such as a family contemplating whether owning a car is a good idea, may study because she is not sure how much she values the product in question. Then, low-income consumers are again more likely to study than high-income consumers who are sure to buy, but it seems difficult for regulations to simplify this studying process. Finally, a consumer may study because she is uncertain as to which of the many horizontally differentiated products she likes. Then, a high-income consumer—such as a rich wine connoisseur—may have more particular tastes and hence study more, and it may be welfare-reducing for policy to increase competition by drastically reducing the selection of products.

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A 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 $(F_i, \{A_i\}_{f_i}, \{\Gamma_i\}_{f_i,a_i})$, where F_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.

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 $\Gamma_i(\gamma_i|\overline{a}, f_i)$ 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 $\overline{a}$, and consumers believe that $\Gamma_i(\gamma_i|f_i) = \Gamma_i(\gamma_i|\overline{a}, f_i)$ 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 $\overline{a}$. Suppose otherwise, that is the firm set some other additional prices with positive probability. Then firm i could deviate and move all probability mass from $A_i(a_i|f_i')$ and $\Gamma_i(\gamma_i|a_i, f_i')$ to a pair $(\gamma', \overline{a})$ 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 $v_H - v_L > \overline{a}$, 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 $\overline{a}$. Furthermore, $\Gamma_i(\gamma_i|\overline{a}, f_i')$ cannot have a mass point on any condition $\gamma_i \in [0, 1]$. Suppose towards a contradiction that $\Gamma_i(\gamma_i|\overline{a}, f_i')$ has at least one mass point, say at γ_i'. If $\Gamma_i(\gamma_i|\overline{a}, f_i')$ has multiple mass points, consider those γ_i' among the mass points that have the largest probability mass conditional on f_i and $\overline{a}$. Low-value browsing consumers will select a γ_i' and avoid the additional price $\overline{a}$ 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 $\overline{a}$ with a larger probability, which increases profits. We conclude that, $\Gamma_i(\gamma_i|\overline{a}, f_i)$ 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 $\overline{a}$ and that $\Gamma_i(\gamma_i|\overline{a}, f_i)$ 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 $\overline{a}$. 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 $\Gamma_i(\gamma_i|f_i) = \Gamma_i(\gamma_i|\overline{a}, f_i)$ 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 $\overline{a}$. $\square$

Because consumers believe that $\Gamma_i(\gamma_i|\overline{a}, f_i)$ 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 supress $\Gamma_i(\gamma_i|\overline{a}, f_i)$ 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 some implications of a firm earning zero profits on equilibrium prices and consumer purchase behavior. Second, using these facts 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): Implications of a firm earning zero profits on equilibrium prices and consumer purchase behavior. We now make some useful observation on candidate equilibria in which some firm j earns zero profits. Note that all firms almost surely set prices $f_i \geq c - \overline{a}$. Otherwise, at least one firm would earn strictly negative profits for prices below $c - \overline{a}$.

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 $\overline{a}$ 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 $a_i = \overline{a}$ when doing so; otherwise, firm i could deviate and increase a_i to $\overline{a}$, 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 $f_i + \overline{a} \leq c + \overline{a}$). Similarly, any firm studying to studying high-value consumers must set $a_i = \overline{a}$ 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 $\overline{a}$ with probability one, and hence charge $f_i = c - \overline{a}, a_i = \overline{a}$ 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 $c - \overline{a}$, 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 $f_j = t_{min} - \overline{a} - \eta, a_j = \overline{a}$, 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. □

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 initial 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 four 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 $a_i = \min\{v_H - f_i, \overline{a}\}$ for any optimal f_i at which high-value consumers buy with positive probability. Third, we prove some properties of f_{min}, namely that $f_{min} + \overline{a} < v_H$, 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}. Fourth, 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 $f_i + a_i \leq v_L + \overline{a} < v_H$. 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.

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

To see this, we first rule out that $a_i < \min\{v_H - f_i, \overline{a}\}$ with positive probability. In this case, firm i can move probability mass from an interval $(0, a_i')$ to a_i', with $a_i' < \min\{v_H - f_i, \overline{a}\}$. 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 $a_i \in (v_H - f_i, \overline{a}]$.

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 $a_i \notin (v_H - f_i, \overline{a}]$. Furthermore, low-value consumers cannot be buying because $f_i > v_H - \overline{a} > v_L$. 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 $(v_H - f_i, \overline{a}]$ to $v_H - f_i$, a contradiction. We conclude that $A_i(\cdot|f_i)$ puts probability one on the additional price $a_i = \min\{v_H - f_i, \overline{a}\}$ 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 $\overline{f}_i$ be the supremum of firm i's headline price distribution and let $f_{max} = \max_i\{\overline{f}_i\}$.

Step (iii): f_{min} is such that $f_{min} + \overline{a} < v_H$, 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}. We first establish that $f_{min} + \overline{a} < v_H$. Suppose otherwise. Then $f_{min} > v_h - \overline{a}$ and hence $f_i > v_h - \overline{a}$ with probability one. Hence, by Step (ii), $f_i + a_i = v_H$ with probability one. Because high-value consumers prefer purchasing at such a total price, high-value consumers purchase with probability one at a total price of v_H. But then one of these firms j does not attract (almost) all browsing high-value consumer that see its headline price. Such a firm j can deviate to a pair of prices $f_j = v_H - \overline{a} - \eta$ and $a_i = \overline{a}$ for some $\eta > 0$ such that $v_H - \overline{a} - \eta > v_L$. For such headline prices, low-value consumer still do not buy, and firm j earns strictly more from browsing high-value consumers. Since a given share ϵ of high-value consumer browses by assumption, such a deviation is strictly profitable for sufficiently small η.

We next show that there is no mass point at f_{min} in any firms' headline price distribution. 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 $a_i = \overline{a}$ 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 $a_i = \overline{a}$ 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 loose through inducing low-value consumers that are initially assigned to it, to study and save on the additional price. Observe, however, that if $f_{min} < v_L$ low-value consumers must study conditional on observing f_{min}, as this guarantees the lowest possible expenditure. Hence, if $f_{min} < v_L$, the loss from low-value consumers is bounded by η. In case $f_{min} \geq v_L$ 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}.

Let i be the firm with a mass point at f_{min}. We consider two cases: case (i) $f_{min} \geq v_L$ and case (ii) $f_{min} < v_L$.

Case (i). Observe that in case (i) low-value consumers do not but at any headline price $f_j >$

f_{min}. 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 $a_{high} = \min\{v_H - f_{max}, \overline{a}\}$. But then a firm could discretely increase its demand from browsing high-value consumers by setting $f_j = f_{max} + a_{high} - \overline{a} - \eta$ and $a_j = \overline{a}$, 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 $f_{max} + \overline{a} \leq v_H$, then as $f_j \to f_{max}$, 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, $f_{max} + \overline{a} > v_H$ then for an interval of prices sufficiently close to f_{max}, firm j charges a total price of v_H. In this case, high-valuation consumers strictly prefer to browse for such prices, and hence j can only earn its equilibrium profits if some other firm also charges a total price of v_H with positive probability; but then again deviating to a price offer $f_j = v_H - \overline{a} - \eta$ and $a_j = \overline{a}$ is profitable for sufficiently small $\eta > 0$. We conclude that $f_{min} < v_L$.

Case (ii). Note that at f_{min} low-value consumers that are initially assigned to firm i must study. We first argue that $\min_{j \neq i}\{\underline{f}_j\} = f_{min}$, for otherwise firm i could deviate to $f_i \in (f_{min}, \min\{\min_{j \neq i}\{\underline{f}_j\}, v_L\})$ and $a_i = \overline{a}$. 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 (i.e. for which $a_i = \min\{v_H - f_{min}, \overline{a}\}$), and they must weakly prefer all offers they accept in equilibrium to those they do not. 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) $f_{min} + \overline{a} < v_L$; (b) $f_{min} + \overline{a} > v_L$; and (c) $f_{min} + \overline{a} = v_L$. In subcase (a) for $f_i \in (f_{min}, v_L - \overline{a})$, browsing low-value consumers still buy after the headline price increase, and hence the firm looses 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 would buy from a rival only if a high-value browsing consumer would also do so, at which case the firm must set $a_j = \min\{v_H - f_j, \overline{a}\}$, contradicting that low-value browsing consumers can receive any surplus from rivals. 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 $\min\{\min_{j \neq i}\{\underline{f}_j\}, v_L\}$ is profitable. We conclude that $\min_{j \neq i}\{\underline{f}_j\} = f_{min}$ in case (ii).

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 $\eta > 0$. It is convenient to again consider the two cases:

(i) $f_{min} \geq v_L$ and case (ii) $f_{min} < v_L$. In case $f_{min} \geq v_L$, for any $f_j \in (f_{min}, f_{min} + \eta)$ firm j does not sell to low-value consumers. Hence at any profit-maximizing headline price in the interval it sells to high value consumers and charges $a_j = \min\{v_H - f_{min}, \overline{a}\}$. But then by deviating and charging prices $f_j = \min\{f_{min} - \eta_2, v_H - \overline{a} - \eta_2\}$ and $a_j = \overline{a}$, firm j attracts all browsing high-value consumers and hence discretely increases its demand from high-value consumers; furthermore for η_2 low enough, $f_j > c$ and hence if firm j induces low-value consumers to buy, this raises profits. We conclude that this is a profitable deviation, ruling out case (i).

Next, we consider case (ii). Consider sufficiently small $\eta > 0$ that satisfy $\eta < \min\{v_L - f_{min}, \overline{a}\}$. 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 price 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 $a_j = \min\{v_H - f_{min}, \overline{a}\} = \overline{a}$. Furthermore, as $\eta \to 0$, 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 is strictly better of 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 looses a payoff of at least $\overline{a} - \eta$ 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 $f_j = f_{min} - \eta, a_j = \overline{a}$ it keeps all consumers initially assigned to it and looses 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. If $f_{min} \geq v_L$, only high-value consumers buy for prices in $(f_{min}, f_{min} + \eta)$, implying that $a_i = \overline{a}$ for these prices. But then firm i could increase profits from all consumers buying at prices in $(f_{min}, f_{min} + \eta)$ by shifting all probability mass from this interval to $f_{min} + \eta$, a contradiction. If $f_{min} < v_L$, also low-value consumers might buy at prices in $(f_{min}, f_{min} + \eta)$. But browsing high-value consumers buy as well with positive probability and again $a_i = \overline{a}$ for these prices. But then firm i could increase profits from all consumers buying at prices in $(f_{min}, f_{min} + \eta)$ by shifting all probability mass from this interval to $f_{min} + \eta$, a contradiction. We conclude that $\underline{f}_i = f_{min}$ for at least two firms i.

Step (iv): All high-value consumers browse with probability one. Suppose towards a contradiction that some high-value consumers study with positive probability. It follows from Step (ii) that there is no benefit of studying for high-value consumers. We first show that if $f_{min} + a_i(f_{min}) < v_H$

there is a strictly positive benefit of browsing with probability one. In this case it follows from Step (ii) that $a_i(f_{min}) = \overline{a}$ and that with probability one $f_{min} + a_i(f_{min}) < f_i + a_i(f_i)$ for all equilibrium price offers. Hence, since at least two firms attain f_{min} and there is no mass point at f_{min}, high-value consumers browse with probability one in this case. Thus, when high-value consumers study with positive probability we must have that $f_{min} + a_i(f_{min}) = v_H$ for all firms i with probability one. But if $f_{min} + a_i(f_{min}) = v_H$, only high-value consumers buy and make zero surplus. But then a firm j can deviate and offer a price pair $f_j = v_H - \overline{a} - \eta$ and $a_j = \overline{a}$. Since by assumption at least a share ϵ of high-value consumers browse, such a deviation strictly increases demand for any $\eta > 0$ and hence is profitable for sufficiently small η. This rules out that $f_{min} + a_i(f_{min}) = v_H$. We conclude that all high-value consumers browse with probability one. □

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 $\overline{f}_i$ be the supremum of firm i's headline price distribution and let $f_{max} = \max_i\{\overline{f}_i\}$.

We proceed in five steps. First, we establish that our second equilibrium-selection assumption implies that $a_i = \min\{v_H - f_i, \overline{a}\}$, and that for any $f_i \leq v_H - \overline{a}$ (on or of the equilibrium path), consumers believe that $a_i = \overline{a}$ with probability one. Second, we prove that $f_{max} \leq v_H - \overline{a}$. 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): $a_i = \min\{v_H - f_i, \overline{a}\}$, and that for any $f_i \leq v_H - \overline{a}$ (on or of the equilibrium path), consumers believe that $a_i = \overline{a}$ 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, $a_i = \overline{a}$ is optimal since they do not see the additional price. For high-value consumers who study, $a_i = \min\{v_H - f_i, \overline{a}\}$ is optimal. Therefore consumers must believe that $a_i \geq \min\{v_H - f_i, \overline{a}\}$. Thus, for any $f_i \leq v_H - \overline{a}$ (on or of the equilibrium path), consumers believe that $a_i = \overline{a}$ with probability one.

Step (ii): $f_{max} \leq v_H - \overline{a}$. We next show that $f_{max} \leq v_H - \overline{a}$. 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 $a_i = \overline{a}$; but since $f_{max} + \overline{a} > v_H$ 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 $f_{max} \leq v_H - \overline{a}$. This implies that $a_i = \overline{a}$ for almost all equilibrium price offers, and that consumers believe that $a_i = \overline{a}$ 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 $1-G_{-j}(f_j) = \frac{1}{I-1}\sum\limits_{i\neq j}\mathbb{P}(f_i > f_j)$ the probability that the average competitor charges a strictly larger headline price than firm j and by $1-G^-_{-j}(f_j) = \frac{1}{I-1}\sum\limits_{i\neq j}\mathbb{P}(f_i \geq f_j)$ the corresponding probability for a weakly larger one. Note that $G_{-j}(f_j) = G^-_{-j}(f_j)$ if no competitor has a mass point at f_j. Since for any $f_j \leq f_{max}$ consumers believe that $a_j = \overline{a}$, low value consumers weakly prefer to browse at such a headline price f_j if and only if

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

which is equivalent to

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

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

$$f_j - c > (1-G_{-j}(f_j))(f_j+\overline{a}-c) + \frac{G_{-j}(f_j)-G^-_{-j}(f_j)}{2}(f_j+\overline{a}-c) + G^-_{-j}(f_j)\times 0,$$

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

$$f_j - c > (1-G^-_{-j}(f_j))(f_j+\overline{a}-c),$$

which is equivalent to

$$\overline{a} < G^-_{-j}(f_j)[f_j-(c-\overline{a})].$$

Since firms must earn positive profits, headline prices are strictly greater than $c-\overline{a}$, and hence $\mathbb{E}(f_{-j}|f_{-j}<f_j) > c-\overline{a}$, 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 $a_i = \overline{a}$. Then another firm j setting f_{max} would be strictly better of setting $f_j = f_{max} - \eta$ and $a_j = \overline{a}$ 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 $a_i = \overline{a}$ 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 $a_i = \overline{a}$; 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 $a_l = \overline{a}$ for these headline price, 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 then 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 $\overline{a}$ 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 $\overline{a}$ 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. $G_{-h}(f) \geq G_{-l}(f)$. 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 $G_{-h}(f) = G_{-l}(f)$, 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 is 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 $a_l = \overline{a}$. 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, $\pi_l > \pi_h$. But firm i could deviate an 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 $G_{-i}(f) = G_{-h}(f)$ 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 study with probability one. □

Proof of Proposition 1. We proceed in five steps. First we determine equilibrium profits and price distributions conditional on f_{max}. Second, we establish that $f_{max} \leq \min\{E(f) + \overline{a}, v_L\}$. 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 $\overline{a}$

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 $f_i + a_i \leq v_L + \overline{a} < v_H$. 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 $f_i \to f_{max}$ 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 $f_i \to f_{max}$. 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 $[G_{-i}(\check{f}) - G_{-i}(\check{f} - \eta)]\check{f}$, while the gain per studying low-value consumer is at least $\hat{f} - \check{f}$. Thus, as $\eta \to 0$, 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 $F(f)$ satisfies

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

Hence, one has

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

and

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

Step (ii): $f_{max} \leq \min\{E(f) + \overline{a}, v_L\}$. 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 $f_{max} \leq E(f_{-i}) + \overline{a}$, where the expectation is taken with regard to the equilibrium headline price distribution $F(f)$. Thus, $f_{max} \leq \min\{E(f) + \overline{a}, v_L\}$.

Step (iii): There exists an $\alpha^* \in (0,1)$ such that $f_{max} = v_L$ if and only if $\alpha \geq \alpha^*$. If $E(f)+\overline{a} \geq v_L$, 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 $E(f)+\overline{a} < v_L$, low-value consumers would prefer to browse when seeing headline prices above $E(f)+\overline{a}$ rather than to study, contradicting the above. In that case, it must be that $\overline{a} = f_{max} - E(f)$ because for any $f_{max} < E(f) + \overline{a}$ 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 $E(f|f_{max} = v_L) + \overline{a} > v_L$. Integration by parts yields

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

Substituting 2 into 3 gives

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

which is increasing in f_{max} because

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

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

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

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

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

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

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

Since

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

one has

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

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 $\alpha \to 0$, implying that $E(f|f_{max} = v_L) + \overline{a} < v_L$. 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 $\frac{\alpha}{I}(f_{max} - c)$ 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 $f_{max} - E(f) = \overline{a}$. Using Equation 4 for the expected price $E(f)$ and applying the implicit-function theorem, we get

$$\frac{\partial f_{max}}{\partial \alpha} = \left[1 - \int_{f_{min}}^{f_{max}} \frac{\alpha}{2(1-\alpha)(f+\overline{a}-c)}df\right]^{-1} \cdot \left[\int_{f_{min}}^{f_{max}} \frac{2(f_{max}-f)}{4(1-\alpha)^2(f+\overline{a}-c)}df\right].$$

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

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

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 $\frac{\alpha}{I}(f_{max} - c)$ are increasing in α. We conclude that the expected consumer payment is increasing in α. □

Proof of Proposition 2. We look for an equilibrium of the same type as in Proposition 1 in which low-value consumers study, high-value consumers browse, and firms charge the maximal additional prices $\overline{a}_L$ and $\overline{a}_H$, and randomize over headline prices according to a common distribution $F(f)$ with support $[f_{min}, f_{max}]$, where $f_{max} \le E(f) + \overline{a}_L$ and $f_{max} < v_L$.

Because $f_{max} \le E(f) + \overline{a}_L$ and $f_{max} < v_L$, 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 $\overline{a}_H$, and since headline prices f_i satisfy $f_i \le v_L \le v_L + \overline{a} \le v_H$ 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 $\overline{a}_L$.

Given the consumers search behavior, firms cannot increase profits by reducing $\overline{a}_H$ or $\overline{a}_L$. 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 $\overline{a}_L$, changing $\overline{a}_L$ does not affect profits, and hence the firms' additional prices are chosen optimally.

We now show that if $\overline{a}_H$ gets smaller, average profits increase. The construction of the equilibrium headline price distribution parallels that in the proof of Proposition 1, and we therefore only sketch it here. With the different notation, the minimum headline price and the distribution of headline prices become

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

and

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

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

We first consider the case where $f_{max} < v_L$. In this case, f_{max} is pinned down by $f_{max} = E(f) + \overline{a}_L$. 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 $E(f) + \overline{a}_L$.

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

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

We know from the proof of Proposition 1 that the first term in squared brackets is always positive. To see that the second term is positive we simplify it

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

$$= 1-\frac{\alpha}{2(1-\alpha)}\ln\left(\frac{f_{max}+\overline{a}_H-c}{f_{min}+\overline{a}_H-c}\right)$$

$$= 1-\frac{\alpha}{2(1-\alpha)}\ln\left(\frac{2-\alpha}{\alpha}\right) > 0.$$

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 therefore know that f_{max} decreases in $\overline{a}_H$. And since $f_{max} = v_L$ whenever $f_{max} < E(f)+\overline{a}_L$, we conclude that average profits and prices decrease in $\overline{a}_H$. We know from *Step (iv)* of Proposition 1 that this expression is positive.

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

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

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

Proof of Proposition 3. 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 incumnet firms' headline price distribution.

We proceed in four steps. First, we pin down equilibrium profits and price distributions. Second, we continue by showing that $f_{max} \leq \min\{(1/2)E(f) + (1/2)E_3(f_3) + \overline{a}, v_L\}$. 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 $\widetilde{f}_3$. Then firms 1 and 2 must set headline prices in an interval $(\widetilde{f}_3, \widetilde{f}_3+\eta)$ 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 $(\widetilde{f}_3, \widetilde{f}_3+\eta)$ for *any* $\eta > 0$, since otherwise firm 3 could increase profits by shifting probability mass from $\widetilde{f}_3$ to a marginally larger headline price. But then an incumbent can increase demand by shifting probability mass from $(\widetilde{f}_3, \widetilde{f}_3)+\eta$ to $\widetilde{f}_3-\eta/2$ 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 $F_1(\cdot)$ and $F_2(\cdot)$ have a connected support. Suppose otherwise that there exists an interval $(\check{f}, \hat{f}) \subset (f_{min}, f_{max})$ such that $F_1(f) = F_2(f) = \text{const.} \in (0,1)$ for all $f \in (\check{f}, \hat{f})$, and take $(\check{f}, \hat{f})$ to be the largest such interval such that incumbent firms set prices in any interval $(\check{f} - \eta, \check{f})$ and $(\hat{f}, \hat{f} + \eta)$ for any $\eta > 0$. Then the headline price of firm 3 either has no probability mass in $(\check{f}, \hat{f})$, or has probability mass only on $\hat{f}$. But then an incumbent firm can strictly increase profits from consumers who buy by shifting probability mass from $(\check{f} - \eta, \check{f})$ to $\hat{f} - \eta/2$ for any $\eta > 0$. Since by Lemma 4, the headline price distributions of firms 1 and 2 have no mass point, the loss in demand goes to zero as 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 $F_i()$ 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 $a_i = \overline{a}$ by Lemma 1 to write the profits of firm 1 as

$$\frac{1}{2}\alpha(f_1 - c) + \frac{1}{2}(1-\alpha)\left[\frac{1}{2}(1 - F_2(f_1)) + \frac{1}{2}(1 - F_3(f_1))\right](f_1 + \overline{a} - c) + \frac{1}{2}\frac{1-\alpha}{2}(1 - F_2(f_1))(f_1 + \overline{a} - c).$$

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

$$\frac{1}{2}\alpha(f_1 - c) + \frac{1}{2}(1-\alpha)\left[(1 - F_2(f_1)) + \frac{1}{2}(1 - F_3(f_1))\right](f_1 + \overline{a} - c). \tag{8}$$

Low-value consumers are a profit base for firms 1 and 2 and these firms earn at least $(1/2)(f_{max} - c)$ by charging f_{max}. They must earn at least these profits for almost all prices in the support, implying that total prices $f_i + \overline{a}$ are almost surely strictly larger than c. Hence $f_{min} + \overline{a} > c$. Therefore the entrant charge the tuple $(f_{min}, \overline{a})$ and thereby profitably attract 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 $\overline{f}_3$, satisfies $\overline{f}_3 < f_{max}$ 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 $f_{min} + \overline{a} - c$ 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 $f_{min} + \overline{a} - c = \frac{2\alpha}{3-\alpha}(f_{max} + \overline{a} - c)$.

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

$$\frac{1}{2}(1-\alpha)\left[\frac{1}{2}(1 - F_1(f_3)) + \frac{1}{2}(1 - F_2(f_3))\right](f_3 + \overline{a} - c).$$

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

$$\frac{1}{2}(1-\alpha)\left[(1-F_2(f_3))\right](f_3+\overline{a}-c). \tag{9}$$

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 $F_3(f) = 0$ for any $f \in (f_{min}, f_{min}+\eta)$. Take this to be the largest such interval, implying that $F_3(f_{min}+\eta+\eta_2) > 0$ for any $\eta_2 > 0$. Using this, (8), i.e. profits of firms 1 and 2, on the interval $(f_{min}, f_{min}+\eta)$, simplifies to

$$\frac{1}{2}\alpha(f_1-c)+\frac{1}{2}(1-\alpha)\left[(1-F_2(f_1))\right](f_1+\overline{a}-c).$$

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

$$\frac{1}{2}(1-\alpha)\left[(1-F_2(f_1))\right](f_1+\overline{a}-c)=\frac{\alpha}{2}\left(f_{max}-f_1\right).$$

Comparing the left-hand-side to (9), 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 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 $\eta_2 > 0$, contradicting 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 $\frac{(1-\alpha)\alpha}{(3-\alpha)}(f_{max}+\overline{a}-c)$. 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, equation (9) implies that for almost all f in the support of firm 3's headline price distribution, we have $F(f) = F_1(f) = F_2(f) = 1-\frac{2\alpha}{3-\alpha}\frac{f_{max}+\overline{a}-c}{f+\overline{a}-c}$.

In the next step, we use $F_2(f)$ and equation (8) as well as the equilibrium profits of firm 3 to get $F_3(f_3) = 1+\frac{4\alpha}{3-\alpha}\frac{f_{max}+\overline{a}-c}{f_3+\overline{a}-c}-\frac{2\alpha}{1-\alpha}\frac{f_{max}-f_3}{f_3+\overline{a}-c}$ for all $f_3 \in (f_{min}, \overline{f}_3)$. It follows from the CDF that $\overline{f}_3 = f_{max}-\frac{2(1-\alpha)}{3-\alpha}(f_{max}+\overline{a}-c) < f_{max}$.

Since $1-F_3(f) = 0$ for all prices $f \in [\overline{f}_3, f_{max}]$, we need to revisit the profits of firm 1 to see that $F(f) = 1-\frac{\alpha}{(1-\alpha)}\frac{f_{max}-f}{f+\overline{a}-c}$ for $f \in [\overline{f}_3, f_{max}]$.

Overall, we get

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

for firms 1 and 2, and for firm 3

$$F_3(f_3)=1+\frac{4\alpha}{3-\alpha}\frac{f_{max}+\overline{a}-c}{f_3+\overline{a}-c}-\frac{2\alpha}{1-\alpha}\frac{f_{max}-f_3}{f_3+\overline{a}-c} \quad \text{if } f \in [f_{min}, \overline{f}_3],$$

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

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

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

and for firm 3

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

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

Step (ii): $f_{max} \leq \min\{(1/2)E(f) + (1/2)E_3(f_3) + \overline{a}, v_L\}$. Similar to Proposition 1, 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 $\overline{a}$, one has $f_{max} \leq (1/2)E(f) + (1/2)E_3(f_3) + \overline{a}$. Overall, we thus have $f_{max} \leq \min\{(1/2)E(f) + (1/2)E_3(f_3) + \overline{a}, v_L\}$.

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 $f_{max} - (1/2)E(f) - (1/2)E_3(f_3) - \overline{a} = 0$. Applying the implicit-function theorem on this expression, we see that

$$\frac{\partial f_{max}}{\partial \alpha} = \left[1 - \frac{1}{2}\int_{f_{min}}^{\overline{f}_3} \frac{2\alpha}{(3-\alpha)(f + \overline{a} - c)} df - \frac{1}{2}\int_{\overline{f}_3}^{f_{max}} \frac{\alpha}{(1-\alpha)(f + \overline{a} - c)} df - \frac{1}{2}\int_{f_{min}}^{\overline{f}_3} \frac{2\alpha(1+\alpha)}{(1-\alpha)(3-\alpha)(f + \overline{a} - c)} df\right] \cdot \\ \cdot \left[\frac{1}{2}\int_{f_{min}}^{f_{max}} \frac{\partial(1 - F(f;\alpha))}{\partial \alpha} df + \frac{1}{2}\int_{f_{min}}^{\overline{f}_3} \frac{\partial(1 - F_3(f;\alpha))}{\partial \alpha} df\right] \tag{10}$$

The second term is positive since all CDFs increase in α at any price in the support. Using the same algebra as in the proof of Proposition 1, 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 $\alpha \to 1$, we can see immediately that $f_{min} \to f_{max}$ and $\overline{f}_3 \to f_{max}$. 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 $\alpha \to 0$, $v_L > (1/2)E(f) + (1/2)E_3(f_3) + \overline{a}$ which implies that $f_{max} = (1/2)E(f) + (1/2)E_3(f_3) + \overline{a} < v_L$. When $\alpha \to 0$, $f_{min} \to c - \overline{a}$ and $f_{3,min} \to c - \overline{a}$. Looking at $E(f)$, we see that the integrands go to zero as $\alpha \to 0$, and since f_{max} is bounded by v_L, this implies that as $\alpha \to 0$, $E(f) \to f_{min} = c - \overline{a}$. Similarly, the integrand of $E_3(f)$ goes to zero as $\alpha \to 0$ and $E_3(f) \to f_{min} = c - \overline{a}$ as $\alpha \to 0$. Overall, we get that as $\alpha \to 0$, $(1/2)E(f) + (1/2)E_3(f_3) + \overline{a} \to c < v_L$.

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 $\alpha \geq \alpha^*$. □

Proof of Proposition 4. 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 it 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 who study do not by, some firm i who charges $f_i + a_i > v_H$ can profitably deviate and use the above pricing strategy, a contradiction. □

Proof of Proposition 5. 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 $f_{min} = f_{max} = c - (1 - \alpha)\overline{a}$.

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 with positive probability, then the firm must set $a_i = \overline{a}$ conditional on charging f_i; hence, high-value browsing consumers also do not buy at f_i. Furthermore, because $f + a > v_H$, we know that $f > v_H - a \geq v_H - \overline{a} \geq v_L$, 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 $f_i = v_H - \overline{a}, a_i = \overline{a}$ 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 $a_i = \min\{\overline{a}, v_H - f_i\}$, 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-vaue consumers browse, a firm could then discretely increase demand by setting a price $f_i = t - \overline{a} - \eta, a_i = \overline{a}$ 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 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 $f_i = v_L - \overline{a}, a_i = \overline{a}$; and if multiple firms charge t_{max}, each of these firms has a strict incentive to deviate to a price $f_i = t_{max} - \overline{a} - \eta, a_i = \overline{a}$ 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 $f_i = v_L - \overline{a}, a_i = \overline{a}$ 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 $a_i = \overline{a}$.

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

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 $\overline{a}$, 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 $f_{max} + \overline{a} < v_H$.

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 $\overline{a}$, 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 $\overline{a}$, firms face Bertrand competition, implying that $f_{min} = f_{max}$. To see this we first rule out mass points at f_max.

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 firms sets a smaller price converges to one. Thus, firm i 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): $f_{min} = f_{max} = c - (1 - \alpha)\overline{a}$. Suppose towards a contradiction that $f_{min} = f_{max} > c - (1 - \alpha)\overline{a}$. 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 $f_{min} = f_{max} = c - (1 - \alpha)\overline{a}$. Low-value consumers pay only this price and high-value consumers additionally pay $\overline{a}$, and firms earn zero profits. □

Proof of Proposition 6. 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.

We next consider the equilibrium with regulation in which $a_i \leq \overline{a}$, 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 $f_i < v_H - \overline{a}$, 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 $f_i \geq v_H - \overline{a}$, 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. For 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 $f_i \in (c - \overline{a}, v_H - \overline{a})$ and $a_i = \overline{a}$, 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 grater 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 $f_i = v_H - \overline{a} - \eta$ and $a_i = \overline{a}$, 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 $f_j \in (c - \overline{a}, v_H - \overline{a})$ and $a_j = \overline{a}$. 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 $f_i = c + \pi/2 - \overline{a}$ and $a_i = \overline{a}$. 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 prices 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 $\hat{a}_i = \overline{a}$ and $\hat{f}_i = v_H - \overline{a} - \eta$ 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 $f_i = \overline{\mathbb{E}} - \overline{a} - \eta$ and $a_i = \overline{a}$, 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 $\mathbb{E}(f_i + a_i|f_i) \to \overline{\mathbb{E}}$, 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 $f_i = \overline{\mathbb{E}} - \overline{a} - \eta$ and $a_i = \overline{a}$, which is profitable for sufficiently small $\eta > 0$. □

Proof of Proposition 7. We first look at the case without regulation, i.e. no price cap $\overline{a}$ on additional prices, and suppose that $\overline{v} > v$. Towards a contradiction, suppose there exists a firm i that sells with positive probability. Consumers do not observe additional prices, implying that they do not observe an increase in a_i and continue to buy from i with the same positive probability. Hence, firm i can increase profits by increasing a_i, a contradiction. We conclude that without regulation and when $\overline{v} > v$, consumers buy with probability zero.

Next, we consider the case without regulation in which $\overline{v} \leq v$. The argument is similar to the previous one. Suppose there exists a firm i that sells at a total price $f_i + a_i \in (\overline{v} - \eta, \overline{v})$ with strictly positive probability for some $\eta > 0$. Again, consumers who buy at these prices do not observe a_i and firm i can increase profits by increasing a_i for all $f_i + a_i \in (\overline{v} - \eta, \overline{v})$ until the total price reaches the usury limit $\overline{v}$, a contradiction. For total prices $f_i' + a_i' = \overline{v}$ the usury limit binds and firm i cannot increase prices. Additionally, since $\overline{v} \leq v$, it is optimal for consumers to buy. Thus, we conclude that without regulation and $\overline{v} \leq v$, consumers buy with probability one at total prices equal $\overline{v}$.

It remains to show that with a price cap $\overline{a}$ on additional prices, consumers buy at a total price c. First observe that all consumers buy with probability one when observing a headline price $f_i \leq v - \overline{a}$. Second, consumers cannot buy in equilibrium at a headline price $f_i > v - \overline{a}$, because if consumers with positive probability buy at a headline price f_i', then it is strictly optimal for the firm to set the corresponding additional price to $\overline{a}$; but then consumers would buy at a total price above their valuation whenever $f_i > v - \overline{a}$. Indeed, anticipating that $a_i = \overline{a}$ for all headline prices, consumers buy from the firm with the lowest headline price. Because each consumer sees two headline prices, standard Bertrand arguments imply that consumers buy at a total price c. □

Proof of Proposition 8. Because f_i and a_i are perfectly negatively correlated, a consumer seeing one of these prices knows both in equilibrium. Hence, a consumer who samples one price component of each firm can perfectly predict all prices. Thus, it is optimal for consumers who put more weight on f to search f from the firms she observes. Similarly, it is optimal for consumers who put more weight on a to search a. This is the attention strategy we impose on consumers (including when seeing an out-of equilibrium price).

Given the consumers attention strategy, our Proposition follows from Proposition 2(i) in Bachi and Spiegler (2015). We provide the argument for convenience. Suppose the marginal distribution is G. When charging f, a, a firm's profit is

$$\frac{1}{2}(1 - G(a) + 1 - G(f))(f + a - c).$$

Taking the first-order condition with respect to a gives

$$1 - G(a) + 1 - G(f) - g(a)(a + f - c) = 0.$$

This immediately shows that the prices must be negatively correlated. Furthermore, with perfect negative correlation $1 - G(a) + 1 - G(f) = 1$, and $a + f = \underline{f} + \overline{f}$. Hence, $g(a) = 1/(\underline{f} + \overline{f} - c)$, that is, the distribution is uniform. Now for the density to integrate to 1, we must have

$$(\overline{f} - \underline{f})\frac{1}{\underline{f} + \overline{f} - c} = 1 \;\Rightarrow\; \underline{f} = \frac{c}{2}.$$

□

Proof of Proposition 9. The result follows essentially from a standard Bertrand argument corrected for the fact that not all consumers need to compare the non-standardized prices. We thus briefly sketch it below.

The standardized price is A for all firms. Denote by $\underline{f}_i$ and $\overline{f}_i$ the infimum and supremum of firm i's price distribution in the non-standardized dimension, and by $\underline{f} = \max_i\{\underline{f}_i\}$ and $\overline{f} = \max_i\{\overline{f}_i\}$ the infimum and supremum among all firms.

We show first that $\underline{f} = \overline{f}$. Suppose otherwise that $\underline{f} < \overline{f}$. Clearly, $\underline{f} \geq c - A$. Furthermore $\underline{f} < \overline{f}$ implies that consumers strictly prefer looking at the non-standardized prices. We establish first that all firms earn positive profits. Take firm i as the firm for which $\overline{f}_i = \overline{f}$. Then all competitors $j \neq i$ must earn positive profits, because they can earn positive profits when competing against firm i by setting $f_j = \overline{f} - \eta$, which attracts consumers from firm i and is profitable for a sufficiently small $\eta > 0$. But if all firms $j \neq i$ earn positive profits, firm i must earn positive profits as well, since it could profitably undercut competitors with positive probability. Thus, all firms must earn positive profits when $\underline{f} < \overline{f}$.

If only one firm i sets $\overline{f}$ with positive probability, it earns zero profits when doing so, contradicting that firms earn positive profits. If two firms set $\overline{f}$ with positive probability, one firm i of these two can increase profits by shifting the probability mass from $\overline{f}$ to $f_i = \overline{f} - \eta$ for some $\eta > 0$ that is sufficiently small. If no firm sets the supremum with positive probability, then for a firm i there must exist a sequence of prices $f_i \to \overline{f}$. But as prices converge to the supremum, demand converges to zero, contradicting that all firms earn positive profits. We conclude that $\underline{f} = \overline{f}$.

We prove next that $\underline{f} = \overline{f} = c - A$. Suppose otherwise that $\underline{f} = \overline{f} > c - A$. Since we assume that a small fraction of consumers always compares non-standardized prices, any firm i can increase profits by setting $f_i = \overline{f} - \eta$ for a sufficiently small $\eta > 0$, a contradiction. We conclude that in the unique equilibrium, all firms set $\underline{f} = \overline{f} = c - A$ with probability one. $\square$

Proof of Proposition 10. We begin by establishing that $f_i = v$ and $f_i + a_i = v + \overline{a}$ for all i, and all consumers studying match values is an equilibrium outcome.

Consumers who study and have the high valuation $v + \overline{a}$ for the premium product buy the premium product if and only if $a_i \leq \overline{a}$ and $f_i + a_i \leq v + \overline{a}$. 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 $f_i + a_i = v + \overline{a}$.

Denote the probability that the consumer prefers the premium version by α. Given that all firms charge $f_i = v$ and $f_i + a_i = v + \overline{a}$, we now show that it is a best response for consumers to study. Browsing and buying the premium product leads to $v + \alpha\overline{a} - (v + \overline{a}) \leq 0$, 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 $f_i + a_i = v + \overline{a}$.

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 $v + \alpha\overline{a} - c$, 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 $\alpha(v + \overline{a} - c) + (1 - \alpha)v$. 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. $\square$