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# De-Targeting: Advertising an Assortment of Products to Loss-Averse Consumers*

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**Abstract**

We consider product markets in which consumers are interested only in a specific product category and initially do not know which product category matches their tastes. Using sophisticated tracking technologies, an intermediary can make inferences about a consumer's preferred product category and offer advertising firms the possibility to target their ads to match the consumer's taste. Such targeting reduces overall advertising costs and, as a direct effect, increases industry profits. However, as we show in this paper, when consumers form reference prices and are loss averse, more precise targeting may intensify competition between firms. As a result, firms may earn higher profits from "de-targeted" advertising; i.e., when the intermediary deliberately informs about some products and their price quotes from outside a consumer's preferred product category.

**Keywords:** Targeted advertising, Informative advertising, Consumer loss aversion, Reference prices, Contextual inference, Consumer recognition, Behavioral industrial organization.

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# 1 Introduction

Sophisticated tracking technologies on the Internet have made targeted advertising a big topic in the business press. As has been widely recognized, targeting improves the effectiveness of advertising and reduces advertising costs.

This is in conflict with casual observations, for instance, when consumers look for a hotel accommodation. While the posted offers better reflect a consumer's taste than a random draw satisfying the consumer's search criteria, some posted offers often turn out, after inspection, to be off the mark and therefore irrelevant for the consumer. As we show in this paper, a portal using tracking technologies may deliberately post some ex post irrelevant offers because the industry may actually benefit from "de-targeting" of advertising.

The core of our argument is based on reference pricing: As is well known from the marketing literature (for example, Rajendran and Tellis, 1994), posted prices affect the utility of consumers when picking one among several products. For instance, if a consumer observes a high-price and a low-price product, which, from an ex ante point of view, she considers relevant, she receives a lower utility when buying the high-price product than in the situation in which she had observed two high-price products. Thus, the posted price of an ex post "irrelevant" alternative may affect consumer evaluations and demand.

With the possibility of tracking and targeting in the Internet age, reference pricing develops a new life because portals can tailor the set of products and prices a consumer observes to the consumer's identity; such tailored offers cannot be made in off-line retailing even when scanner data about consumers' purchase behavior are collected. Using the concept of expectation-based loss aversion, we show in this paper that the assortment of products encountered by consumers may affect their demand. Note that this holds only for products a consumer expects to buy with positive probability when seeing the ads. Portals decide on the assortment of products and thus determine a consumer's consideration set. We show that with loss-averse consumers using reference prices, competition between producers becomes more intense the better advertising is targeted to a consumer's preferred product category compared to a setting with loss-neutral consumers. As a result, from an industry perspective, it may be optimal to expand the consumers' consideration set.

We propose a model of informative advertising in which consumers face a discrete choice problem among products within a product category. An intermediary – for example, an advertising agency or an internet portal – can identify the specific product category a consumer is interested in, but not the consumer's preferred product within this category. Perfect targeting in our context means that the consumer sees only ads of the products from her preferred product category; we call this *perfect category targeting*.[1] The main result of this paper is that firms benefit from the introduction of some noise into category targeting. We call this practice *de-targeting*. In particular, firms benefit from advertising products outside the consumers' preferred product category. Advertising such products to consumers, generates additional advertising costs but, for given prices, no revenues. The reason is that advertising additional products expands a consumer's consideration set, even though the consumer will never buy any of those products outside the category she likes. How can such apparently wasteful advertising be optimal from the perspective of the industry? We present a novel behavioral explanation based on the interaction between the effect of reference prices (when consumers are loss averse) and the set of advertised products. In a nutshell, consumer loss aversion and the advertising strategy of the intermediary interact: de-targeting mitigates the expected gains and losses consumers experience and effectively relaxes competition between firms; the intermediary internalizes this effect on industry profits.

We distinguish between a contact stage and an inspection stage. At the contact stage, advertising informs a consumer about the existence and price of a set of products, which constitutes a consumer's consideration set. At the inspection stage, the consumer learns about her preferred product category (if it has been included in her consideration set) and her match value of products in that category. Based on the information received from advertising, but prior to learning about her preferred product category and match values, a consumer forms expectations about how likely she is to buy an advertised product (this timing resembles that in Karle and Peitz, 2014). At the purchase stage, she experiences gains or losses if her actual choice does not confirm her initial expectations, where losses loom larger than gains.[2] Consumers assign the correct purchasing probabilities ex ante; thus, their expectations are rational given the information available, which is in line with the concept of expectation-based loss aversion by Kőszegi and Rabin (2006, 2007).[3]

Under consumer loss aversion, advertising additional products – i.e., de-targeting – affects

[1]In line with the discrete choice literature of product differentiation, a consumer's utility function includes a random variable whose realization is unknown to firms and the intermediary. Product differentiation within a category arises from idiosyncratic realizations of these random variables. If this variable is i.i.d. over time, past realizations do not provide indications about future individual demand and, hence, do not enable targeting *within* a product category.

[2]In our base model, we restrict attention to loss aversion in the price dimension only. As we show in Section 5.2, including loss aversion in the taste dimension does not affect our main result.

[3]There is extensive recent empirical evidence from the lab (Abeler et al., 2011, Ericson and Fuster, 2011, Gill and Prowse, 2012, and Karle et al., 2015) and from the field (Pope and Schweitzer, 2011 and Crawford and Meng, 2011) that losses drive behavior more strongly than gains, and that reference points are expectation based. Support also comes from earlier contributions in the marketing literature which suggests that loss aversion with respect to price affects consumer choice (for an overview, see Mazumdar et al., 2005). In particular, Rajendran and Tellis (1994) suggests that reference prices are based on the prices of similar products at the moment of purchase.

a consumer's reference point and thus the consumer's demand function. If more products are advertised to consumers, then, due to consumers' initial taste uncertainty, the purchase of any given product becomes less likely. This also applies to products which are offered at a reduced price relative to other products. Observing more products then makes consumers less price sensitive to each product. Therefore, de-targeting results in higher equilibrium prices. What de-targeting does, is that it places consumers in a different context. In this sense, our model formalizes contextual inference about the expected purchase price when consumers are loss averse and addresses the role of the intermediary in "manipulating" consumer beliefs.

The intermediary, acting on behalf of advertising firms, adjusts its advertising strategy to balance the cost-reducing effect of more precise targeted advertising with the competition effect that arises under consumer loss aversion. Indeed, as our paper shows, when advertising costs are not too high, the intermediary optimally refrains from perfect category targeting and advertises more products even though it knows from the start that the consumers will never buy them.

To illustrate the idea of de-targeting under consumer loss aversion, we return to the portal for hotel accommodations that provides listing services. As pointed out above, portals make recommendations that, upon closer inspection by the consumer, turn out to be completely off the mark, but could have been filtered out based on the user's profile. When looking for a hotel accommodation, consumers see a set of recommended hotel rooms satisfying some specified quality and horizontal characteristics and their prices. Based on this information, consumers consciously or unconsciously form their expected purchase price (i.e., a probability distribution over posted prices). Then, before making their purchase decision, they obtain more detailed information about those hotels. According to our theory, when the portal knows ex ante which narrow set of offers a consumer may be interested in, it displays additional offers to manage a consumer's price expectations. Thus, we rationalize the portal's de-targeting strategy.

A similar situation arises when potential buyers and sellers of a house interact through a real estate agent. The business practice of the real estate agent may be to schedule several house visits so as to affect the buyers reference prices. For instance, the agent may tell the perspective buyer upfront that they are going to visit a certain number of houses, their respective prices and some of their characteristics. The agent may systematically include some offers that, as the agent privately knows, will not be of interest to the particular buyer. Including those offers affects the buyer's probability distribution over the expected purchase price and, therefore, the expected demand function.

We show that our de-targeting result carries over to a model with competing intermediaries although they are somewhat less inclined to use de-targeting than a monopoly intermediary.

Competing intermediaries here carry up to one product per category, but still partially internalize how the advertising strategy affects competition under consumer loss aversion. Various extensions confirm the robustness of our main result allowing for asymmetric product categories, consumer loss aversion also in the taste dimension, and multi-product advertisers. In particular, when product categories differ in marginal costs and these differences are not too large, de-targeting continues to be part of the optimal advertising strategy, and equilibrium prices are symmetric among all firms with products within the same consumer consideration set. Hence, de-targeting here features heterogeneous price-cost margins in contrast to what would happen under perfect category targeting. It also provides a novel rationale for focal pricing.

De-targeting tends to be attractive from an industry perspective for products with low prices. If the intermediary can condition its advertising strategy on the consumer type and consumers naively believe that each advertised category is equally likely to be their preferred one, our model predicts that consumers interested in a category with low-priced products tend to see ads for high-priced products together with low-priced products, while consumers interested in a category with high-priced products will not see ads for low-priced ones.[4]

The paper proceeds as follows. Section 2 provides a guide to the related literature. Section 3 presents the formal model. Section 4 establishes our result on the anti-competitive effect of de-targeting: a monopoly intermediary who coordinates the advertising activities of firms refrains from perfect category targeting and instead advertises products more broadly. We extend this result to competing intermediaries. Section 5 provides several extensions allowing for asymmetric product categories, consumer loss aversion also in the taste dimension, and multi-product firms. Section 6 provides a discussion of a number of additional issues. Section 7 concludes. Further material is provided in several appendices. Appendix A contains a relegated lemma. Appendix B characterizes the demand function for arbitrary price vectors. Appendix C reports the equilibrium price correspondence. Appendix D presents the analysis of advertising when it leads to monopoly sellers in each category and parameter restrictions that rule out this monopoly to emerge in equilibrium. Appendix E contains relegated material on equilibrium existence.

## 2 Literature Review

Our paper contributes to the literature on targeted advertising and, in particular, the competitive consequences of targeting. The existing literature has analyzed targeting in monopoly

[4] A more elaborate discussion of this point is found in Section 7.

and oligopoly contexts; recent contributions include Roy (2000), Esteban et al. (2001), Iyer et al. (2005), Gal-Or et al. (2006), Galeotti and Moraga-Gonzalez (2008), Anand and Shachar (2009), and Chandra (2009). The general finding of that literature is that targeting increases profits which stands in contrast to our main result.[5] An exception is de Corniere (forthcoming). In his setting, consumers search sequentially, and oligopolistic firms may be worse off under targeting. The reason is that targeting affects the stopping rule of consumers and makes competition more intense, as additional search is more likely to lead to a good match. Our de-targeting result is markedly different from his argument. While he argues that targeting affects consumers' search behavior, our explanation is grounded in targeting affecting consumers' reference prices. Furthermore, we focus on category targeting and exclude the possibility of product-specific targeting.

De-targeting may also occur as a response to privacy concerns as it may reduce or remove a consumer's perceived privacy infringement and may therefore be beneficial for the industry. In particular, from the firms' perspective, obtrusive ads are better shown in a context of de-targeting – Goldfarb and Tucker (2011), provide evidence from a field experiment in support of this view. This explanation is orthogonal to ours and applies only to contexts in which targeted ads are considered to be obtrusive.

Our paper contributes to the broader question how many products will be advertised to consumers. In particular, empirical evidence on choice overload suggests that exposing consumers to more products may reduce purchase probability (e.g., Iyengar and Lepper, 2000). This suggests that firms may actually want to limit the number of products shown to consumers. We note that our argument does not require a large number of advertised products and is, therefore, not in conflict with the empirical evidence on choice overload.

Prominent explanations of choice overload include consumer search (Kuksov and Villas Boas, 2010) and Bayesian inference on the likely fit between tastes and product characteristics (Kamenica, 2008). Kamenica (2008) points to contextual inference about the match value of a product. By contrast, our analysis focuses on contextual inference about the expected price in a model with loss aversion: consumers make inferences from the number of advertised products and their prices on the expected purchase price.

Our paper also provides an answer to the question how many consumers will be exposed to an ad. While de-marketing has the feature that some consumers are not shown advertising for a product even though this reduces demand (for an explanation see Miklos-Thal and Zhang, 2013), we show that an ad is shown deliberately to some consumers even though they never

[5] A different mechanism that generates lower profits under targeting requires targeted pricing: firms can condition price on consumer tastes, as pointed out in the literature on customer recognition. Then, better information on consumer tastes leads to more intense competition (e.g., Fudenberg and Tirole, 2000). For a model that includes advertising, see Esteves and Resende (2015).

consider buying the advertised product (which we refer to as “de-targeting”).

Our paper also contributes to the analysis of behavioural biases in market settings, as in DellaVigna and Malmendier (2004), Eliaz and Spiegler (2006), Gabaix and Laibson (2006), and Grubb (2009).[6]

More specifically, this paper contributes to the understanding of the implications of expectation-based consumer loss aversion (Kőszegi and Rabin, 2006) in market settings.[7] A first subset of papers (Heidhues and Kőszegi, 2014; Rosato, 2015; Karle, 2013) consider monopoly markets and show that by introducing (or maintaining) uncertainty in consumption outcomes of expectation-based loss-averse consumers, a firm can modify consumers’ outside options by making some plans not credible although they were favorable from an ex-ante viewpoint.[8]

In particular, Heidhues and Kőszegi (2014) examine a monopolist’s optimal pricing strategy when expectation-based loss-averse consumers decide upon buying one unit of a product with a known, common valuation. They show that the monopolist infrequently offers variable sales prices. At these prices not buying the good is not a credible equilibrium strategy for consumers. This shifts consumers’ reference point in favor of buying the good. In a different application, Rosato (2015) shows that a retailer selling two substitute goods can attach homogeneous, expectation-based loss-averse consumers by means of a tempting discount on a good available only in limited supply. The retailer then cashes in with a high price on the substitute good available in unlimited supply. In the informative advertising model of Karle (2013), a monopolist can induce an attachment effect with heterogeneous, expectation-based loss-averse consumers. He does so by maintaining some residual uncertainty after advertising about the product match for high-type consumers.

In our paper, we show that introducing uncertainty in consumption outcomes of expectation-based loss-averse consumers can be even profitable in oligopolistic product markets, where uncertainty is generated by costly and socially wasteful advertising. In contrast to the other papers, no attachment effect plays out in our setting.

Two other papers model the behaviour of expectation-based loss-averse consumers in oligopolistic product markets. Heidhues and Kőszegi (2008) predict less price variation across products (focal prices) and over time (sticky prices), in a setup in which consumers incorporate information about expected price levels into their reference points prior to observing posted prices. When posted prices are observable at the reference-point-formation stage, however,

[6]For overviews, see Ellison (2006); DellaVigna (2009); Spiegler (2011a); Kőszegi (2014); Grubb (2015).

[7]Other applications of this loss aversion concept, in particular its applications to contract theory, include Carbajal and Ely (2014), Hahn et al. (2014) and Herweg and Mierendorff (2013) on monopolistic screening, Macera (2011) and Herweg et al. (2010) on agency contracts, Lange and Ratan (2010) and Eisenhuth and Ewers (2012) on sealed-bid auctions, and Daido and Murooka (forthcoming) on team incentives.

[8]Cf. also Spiegler (2011b) for a model with sample-based reference points.

Karle and Peitz (2014) show a price variation-increasing, pro-competitive effect of consumer loss aversion in duopoly.[9] Karle and Peitz (2014) is closest to our paper with respect to the information available to consumers when forming their reference point: posted prices are observed but match value is uncertain when the reference point is formed. Relative to Karle and Peitz (2014) our contribution is to present a framework in which the number of products a consumer is exposed to is endogenously determined by the advertising strategy of an intermediary. Our paper thus combines an oligopolistic product market with the multi-product advertising strategy of a monopolist.[10]

# 3 Model

Firms engage in informative advertising to sell their products to consumers. They do so via an intermediary. Hence, there are three types of market participants, a "small" number of firms, a "large" number of consumers and a monopoly intermediary.

*Consumers.* Consumers maximize utility. They make a discrete choice among the products they are informed about and have unit demand. They derive positive utility from products in one category only; products in all other categories give zero utility. Absent loss aversion, a consumer of type $(x, k)$ with location $x \in [0, 1]$ in her preferred product category $k \in \{1, ..., J\}$ would obtain utility $v - t|x - y_i| - p_i$ when buying one unit of product $i$ (where $p_i$ denotes the price of firm $i$ and $y_i$ the location of firm $i$) if $i$ belongs to product category $k$ and utility 0 when buying some product $i$ that does not belong to product category $k$.

There is mass 1 of consumers. We consider a symmetric setting such that a fraction $1/J$ of consumers are interested in a particular product category. Before introducing consumer loss aversion, it is useful to describe firms and the intermediary.

*Firms.* Each firm produces a single product that belongs to one of $J$ product categories. There is duopoly competition within each product category. For simplicity, we assume Hotelling competition in each product category. Thus, there are $I = 2J$ products sold by single-product firms. Each firm is located at either one of the extreme points of the Hotelling line. We order firms such that firms $2j - 1$ and $2j$ are located in category $j$; firm $2j - 1$ is located at 0 and firm $2j$ at location 1 on the Hotelling line in category $j$. Denoting $\hat{x}_j$ as the indifferent consumer in segment $j$, demand of firm $2j - 1$ is $\hat{x}_j/J$ and demand of firm $2j$ is $(1 - \hat{x}_j)/J$. Firms incur constant marginal costs of production $c$. Therefore, profits of firms $2j - 1$ and $2j$

[9] Zhou (2011) and Spiegler (2011b) consider consumers with history-based and sampling-based reference points in an oligopolistic and a monopolistic setting, and partly confirm the results of the two former papers.

[10] Different from these two papers, for expositional clarity, we consider loss aversion in the price dimension only. Yet, as we show in the extension section, our main insight is robust to allowing for loss aversion also in the taste dimension.

are $(p_{2j-1} - c)\hat{x}_j/J$ and $(p_{2j} - c)(1 - \hat{x}_j)/J$, respectively. Firms set prices simultaneously to maximize their profits.

The equilibrium of the price setting game determines industry profits. We make the assumption that the industry profit under symmetric duopoly $2\pi^d$ exceeds the industry profit that would result under monopoly $\pi^m$, i.e., when only one ad of the category of interest is shown instead of two. As a consequence of this assumption, the intermediary will advertise both products in the same product category. In terms of the underlying structural parameters, for the inequality $2\pi^d > \pi^m$ to hold we have to require that the value of parameter $v$ is not too high or the transportation cost parameter $t$ sufficiently large (i.e., product differentiation is sufficiently large).[11] A necessary condition for this inequality to hold is partial market coverage under monopoly. We also assume that there is full market coverage under duopoly competition; i.e., the outside option not to buy does not bind. We thus must be in an intermediate range of the stand-alone utility $v$ such that there is partial market coverage under monopoly and full coverage under competition. As we show in Web Appendix D, we can establish conditions on the underlying structural parameters for the inequality $2\pi^d > \pi^m$ to hold.[12]

*Intermediary.* We consider an intermediary coordinating advertising decisions on behalf of firms. We formalize this by assuming that the intermediary passes all advertising costs on to firms and absorbs a constant fraction $\beta$ of industry profits. We make this assumption to make sure that the intermediary makes a difference only because it internalizes externalities; in the discussion section we show that our main insight is robust if the intermediary charges a fixed fee for its service (which is set either by the intermediary or collectively by the firms).

Suppose that the intermediary can make use of a tracking technology which allows it to perfectly identify a consumer's preferred product category. However, it cannot infer the location of the consumer on the Hotelling line; i.e. tracking reveals $k$, but not $x$.[13] The intermediary announces all products of at least one category; this follows from our assumption $2\pi^d > \pi^m$.

We say that the intermediary implements *perfect category targeting* if it advertises only the two products belonging to category $k$. Otherwise, if also products from other categories are advertised to each consumer, we say that category targeting is imperfect.

To place an ad, the intermediary has to pay advertising costs $a$ per unit mass of consumers

[11] In Section 6 we show that this condition can be weakened when taking a different look at the business model of the intermediary.

[12] With consumer loss aversion, we have to determine equilibrium profits both under monopoly and under competition. The analysis under competition follows in Section 4, while the analysis of the monopoly case under consumer loss aversion is also relegated to Web Appendix D. Throughout our analysis we presume that the explicit conditions established in that appendix are satisfied.

[13] Translated into a repeat purchase setting, this means that latent consumer characteristics allow the intermediary to infer $k$, but idiosyncratic taste differences that change over time (and are unobservable to the intermediary) determine the consumer preferences within their preferred category.

per product. Thus, if all products are advertised to all consumers total advertising costs are $2Ja$, which is the upper bound on advertising costs. Since we assumed that the intermediary passes all advertising costs it has to pay on to firms and receives a fraction of firms' profits, this implies that the profit-maximizing intermediary acts in the interest of industry and maximizes industry profits.

*Consumer loss aversion.* Consumer are loss aversion in the price dimension.[14] Let $\mathbf{p} \equiv (p_1, ..., p_{2J})$ denote the price vector of the $2J$ firms. Suppose that a consumer interested in category $k$ observes prices from a weak subset of all firms $S_k \subseteq \{1, \dots, 2J\}$ before forming her reference point. The set $S_k$ then constitutes the consideration set of consumers interested in category $k$. Note that it is not essential that all consumer interested in $k$ observe the same set of products. The number of products is the same for all these consumers, but they may see different products outside category $k$. Consumers initially do not know their type; i.e., they do not know which is the product category $k$ they like nor what is their value $x$. To find out, they have to inspect products after forming their reference points. Inspection is costless. Here, consumers only have to learn which category they are interested in and inspect products in this category.

Since the intermediary recognizes each consumer's preferred category, it advertises both products from category $k$; i.e. $2k-1$ and $2k$ are element of $S_k$. Suppose that this is the case and that all except firm $2k-1$ set the same price $p'$. If firm $2k-1$ sets a weakly lower price $p_{2k-1}$ than all other firms, i.e. $p_{2k-1} \leq p'$, consumers with preferred category $k$ obtain utility

$$u_{2k-1}(x, \{p_i\}_{i \in S_k}) = v - tx - p_{2k-1} + \eta(1 - \text{Prob}[p = p_{2k-1}; \{p_i\}_{i \in S_k}])(p' - p_{2k-1}) \tag{1}$$

when buying product $2k-1$.

The last additive term on the right-hand side captures the gain due to the lower price weighted by $\eta > 0$. Note that this gain depends on the probability of the complementary event; i.e., the probabiliy by which the consumer expected to buy at price $p'$. This captures the idea that gains (or losses) are weighted more heavily, the less expected they are (cf. Kőszegi and Rabin, 2006). For the competing product, consumers with preferred category $k$ obtain utility

$$u_{2k}(x, \{p_i\}_{i \in S_k}) = v - t(1 - x) - p' - \lambda\eta\text{Prob}[p = p_{2k-1}; \{p_i\}_{i \in S_k}](p' - p_{2k-1}). \tag{2}$$

Loss aversion is expressed by the fact that gains enter with weight 1, while losses, weighted by $\lambda$, loom larger than gains; i.e., $\lambda > 1$. The analogous expressions to (1) and (2) apply if

[14] In our symmetric setting, our comparative statics result is confirmed when consumers are also loss averse in the taste dimension; see Section 5.2.

firm $2k-1$ sets a higher price than all other firms. Consumers with preferred category $k' \neq k$ observe the same price $p'$ for both products in category $k'$ and obtain the same gain for each of the two products. Hence, their purchase behavior is the same as without consumer loss aversion.

*Timing.* We distinguish four stages at which decisions are made or expectations are formed.

1. *Advertising.* The intermediary commits to its advertising strategy that informs each consumer $(x, k)$ about a set of products $S_k$.

2. *Pricing.* Firms decide whether to advertise and set prices $p_i$ simultaneously.

3. *Reference point formation.* Consumers observe prices of the advertised products (but not yet their preferred category) and form their probabilistic reference point.

4. *Consumer purchase.* Consumers learn $k$ and inspect the advertised products in this category and make their purchasing decision.

We solve for subgame-perfect Nash equilibrium where intermediary and firms foresee that consumers play a personal equilibrium (as defined by Kőszegi and Rabin, 2006);[15] i.e., consumers hold rational expectations about their final purchasing decision and, at the last stage, behave accordingly. At the end of Section 4, we allow for competing intermediaries where each intermediary caters to one firm in each category and they choose their advertising strategy simultaneously.

As a backdrop, it is useful to mention what happens without loss aversion. In this case, the intermediary commits to perfect category targeting (i.e., consumers learn only about the products in their preferred category). The reason is that without loss aversion demands are independent across category. Therefore, incurring advertising costs for a product with zero demand cannot maximize industry profits. Thus, our result that the intermediary does not choose perfect category targeting, is due to consumers being loss averse.

# 4 The Optimality of De-Targeting

In this section, we establish our main result that, under some weak conditions, consumer loss aversion causes the intermediary to refrain from perfect category targeting. We solve the game described in the previous section by backward induction with consumers playing a personal equilibrium.

[15] Given prices, there exists a unique personal equilibrium, which trivially is a preferred personal equilibrium, as defined by Kőszegi and Rabin (2006).

*Equilibrium Demand.* We consider symmetric equilibria. Denote $s \leq J$ as the number of product categories disclosed to each consumer; i.e., the cardinality of the consideration set $S_k$ is equal to $2s$ because there are two products per category. In the last stage, given observed prices $\{p_i\}_{i\in S_k}$, a consumer learns the combination $(x, k)$ of her preferred product valuation and category and makes her consumption choice given her reference point distribution; i.e., she considers buying from firm $2k-1$ or firm $2k$ and never buys from any other firm. She purchases one of the two if at least one product in category $k$ is advertised to her at a sufficiently low price.

To keep the notation simple, we consider product 1 in product category 1; however, the following argument is valid for any product. We use the notation, $\mathbf{p} = (p_1, p', ..., p')$ to consider a deviation by firm 1 from price $p'$. By symmetry, the indifferent consumer in any category different from category 1 is characterized by $(1/2, k)$, for $k \neq 1$. The indifferent consumer in category $k = 1$, $(\hat{x}_1, 1)$, can be characterized by $\Delta u(\hat{x}_1, \{p_i\}_{i\in S_1}) \equiv u_1(\hat{x}_1, \{p_i\}_{i\in S_1}) - u_2(\hat{x}_1, \{p_i\}_{i\in S_1}) = 0$ using utility functions in (1) and (2). It holds that

$$\Delta u(\hat{x}_1, \{p_i\}_{i\in S_1}) = \Big(1 + \eta + \eta(\lambda - 1)\mathrm{Prob}[p = p_1; \{p_i\}_{i\in S_1}]\Big)(p' - p_1) - t(2\hat{x}_1 - 1). \tag{3}$$

To solve the underlying fixed point problem (i.e. for consumer's personal equilibrium), we use that the probability $\mathrm{Prob}[p = p_1; \{p_i\}_{i\in S_1}]$ a consumer assigns to buying from firm 1 depends on her rational expectations at stage 3. First, given the consideration set of product prices $S_1$, the probability of buying product 1 is the probability that the consumer prefers category 1 times the probability that such a consumers buys product 1; i.e., $\mathrm{Prob}[p = p_1; \{p_i\}_{i\in S_1}] = \mathrm{Prob}[k = 1; \{p_i\}_{i\in S_1}] \cdot \mathrm{Prob}[x \leq \hat{x}_1 | k = 1]$. Second, because of the uniform distribution of consumers' valuations within categories and the fact that all categories are equally likely to be a consumer's preferred category at stage 3, $\mathrm{Prob}[p = p_1; \{p_i\}_{i\in S_1}] = (1/s) \cdot \hat{x}_1$ for given prices $\mathbf{p} = (p_1, p', ..., p')$ and number $s \in \{1, ..., J\}$ of product categories disclosed to each consumer.

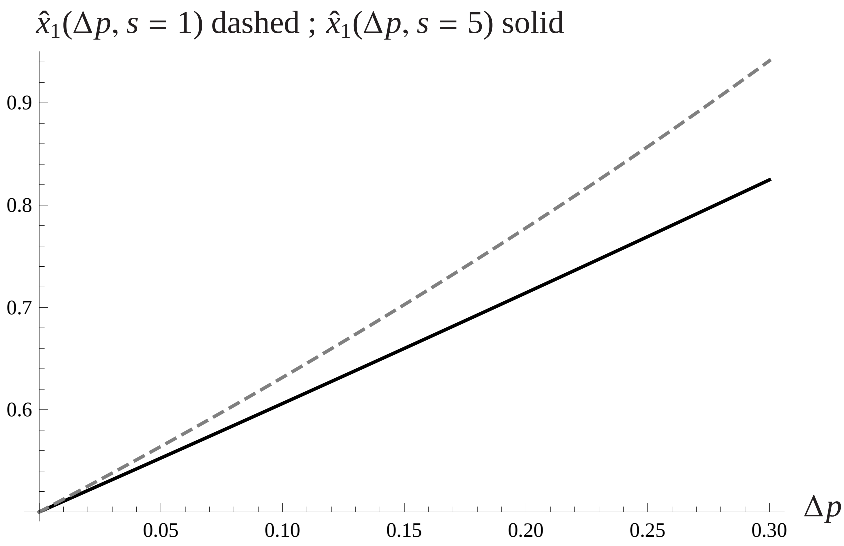
The following lemma pins down the location of the indifferent consumers and firms' demand.

**Lemma 1.** *Suppose that $\Delta p \equiv p' - p_1 \geq 0$, where $\mathbf{p} = (p_1, p', ..., p')$ and $p', p_1 \geq 0$. Then, the indifferent consumers per category are located at*

$$\hat{x}_1(\Delta p, s) = \min\{\frac{s(t + (1 + \eta)\Delta p)}{2st - \eta(\lambda - 1)\Delta p}, 1\},$$

*and $\hat{x}_j(p_{2j} - p_{2j-1}, s) = 1/2$ for all $j \in \{2, ..., J\}$. The demand of firm $2j - 1$ and $2j$ are given by $D_{2j-1}(p_{2j} - p_{2j-1}, s) = 1 - D_{2j}(p_{2j} - p_{2j-1}, s) = \hat{x}_j(p_{2j} - p_{2j-1}, s)/J$ for all $j \in \{1, ..., J\}$.*

*Proof of Lemma 1.* Mainly in the text. It is left to show that given $\mathrm{Prob}[p = p_1; \{p_i\}_{i\in S_1}] = \hat{x}_1/s$, $u_1(\hat{x}_1, \{p_i\}_{i\in S_1}) - u_2(\hat{x}_1, \{p_i\}_{i\in S_1}) = 0$ is equivalent to the equation in the lemma. This is




The location of the indifferent consumer in category 1 (=$J \times$ demand of firm 1) as a function of $\Delta p = p' - p_1$ for parameter values of $t = 1$, $\lambda = 2$, and $\eta = 1$.

Figure 1: Demand for Perfect and Imperfect Targeting

achieved by a sequence of simple equation manipulations and taking into account that cutoffs must lie in $[0, 1]$. □

For any advertising strategy and price vector, the personal equilibrium is unique. The *unique pure-strategy personal equilibrium* of a consumer with realized type $(x, k)$ is described by the product she turns out to buy

$$\sigma(x, k; \{p_i\}_{i \in S_k}) = \begin{cases} 2k - 1 & \text{if } x \in [0, \hat{x}_k(p_{2k} - p_{2k-1}, s)] \\ 2k & \text{if } x \in (\hat{x}_k(p_{2k} - p_{2k-1}, s), 1]. \end{cases}$$

These actions give rise to an expected probability distribution over products. For an arbitrary price vector, the reference point distribution and demand are derived in Web Appendix B. As illustrated in Figure 1, the demand of firm 1 (as characterized in Lemma 1) becomes less price sensitive when imperfect targeting is used instead of perfect category targeting.

To understand this property, we compare perfect category targeting to a situation in which products of two categories are advertised. Consider first the price sensitivity at price level $p'$ under perfect category targeting. Suppose that firm 1 reduces its price to $p_1 < p'$, where $p'$ is the price set by all other firms. In personal equilibrium, consumers expect to buy product 1 with some probability greater than $1/2$. Take the marginal consumer $\hat{x}_1(p_1 - p', 1)$, short $\hat{x}_1$. Her utility is $u_1^1 \equiv v - t\hat{x}_1 - p_1 + \eta(1 - \hat{x}_1)(p_1 - p')$ if she buys product 1, while her utility is $u_2^1 \equiv v - t(1 - \hat{x}_1) - p' - \lambda\eta\hat{x}_1(p_1 - p')$ if she buys product 2. As she is the marginal consumer, we must have $u_1^1 = u_2^1$. This determines the probability in personal equilibrium, $\hat{x}_1(p_1 - p', 1)$, as a function of the parameters of the model.

Suppose now instead that the intermediary advertises all products from two product categories. As we will see, for the price deviation $p_1 < p'$, in personal equilibrium the expected probability of buying product 1 conditional on the consumer being interested in product category 1 is now different from $\hat{x}_1(p_1 - p', 1)$. In which direction does it change? Assume that a consumer who learns that she prefers product category 1 uses this probability $\hat{x}_1$. Then, she will obtain utility $u_1^2 \equiv v - t\hat{x}_1 - p_1 + \eta(1 - \hat{x}_1/2)(p_1 - p')$ from consuming product 1, as she experiences a gain with probability $1/2 + (1/2)(1 - \hat{x}_1)$; alternatively, she obtains utility $u_2^2 \equiv v - t(1 - \hat{x}_1) - p' - \lambda\eta(1/2)\hat{x}_1(p_1 - p')$, as she experiences a loss with probability $(1/2)\hat{x}_1$ when buying product 2. Hence, when products from two categories are advertised it becomes more likely to experience a gain and less likely to experience a loss than under perfect category targeting. We have that $u_1^2 = u_1^1 + \eta\hat{x}_1(p' - p_1)/2$ and $u_2^2 = u_2^1 + \eta\lambda\hat{x}_1(p' - p_1)/2$. As $u_1^1 = u_2^1$ and losses loom larger than gains ($\lambda > 1$), we must have $u_1^2 < u_2^2$. Therefore, the personal equilibrium when two product categories are advertised must feature $\hat{x}_1(p_1 - p', 2) \in (1/2, \hat{x}_1(p_1 - p', 1))$. We have thus shown that while, under perfect category targeting, the price deviation generates $\hat{x}_1(p_1 - p', 1) - 1/2$ additional consumers for firm 1, it generates only $\hat{x}_1(p_1 - p', 2) - 1/2$ additional consumers for that firm under imperfect category targeting (where products from two categories are advertised). Thus, de-targeting reduces the price elasticity of demand.

We recall that, absent loss aversion, demand is independent across categories. The novel feature of consumer loss aversion is that it links demand across otherwise unrelated product categories. An equivalent way to think about advertising additional products, is to announce those products at the same price instead of charging an infinite price (the latter is equivalent to products not being available). Consumers expect to buy a product at infinite price with probability zero, while announcing products at the same price reduces expected demand from consumer's preferred product category (but not actual demand). Hence, consumer loss aversion makes the demand in product category $k$ dependent on prices in all other categories, as those prices affect the likelihood that a consumer experiences gains and losses after a price deviation by a firm offering a product in category $k$.

*The Symmetric Equilibrium Markup*. To characterize the symmetric equilibrium markup at stage 2 for given $s$, it is sufficient to show that a price deviation by a single firm is not profitable, given equilibrium prices of all other firms. The maximal equilibrium is characterized when solving the first-order conditions that apply when a firm slightly decreases its price.

**Proposition 1.** *The maximal symmetric equilibrium markup is given by*

$$p_i^*(s) - c = \frac{2t}{2(1+\eta) + \frac{\eta(\lambda-1)}{s}}, \quad i \in \{1, ..., 2J\}. \tag{4}$$

*It is strictly increasing in the number $s \in \{1, ..., J\}$ of product categories disclosed to each consumer.*

*Proof of Proposition 1.* The proof follows directly from the first-order condition of firm 1's profit maximization problem w.r.t. $p_1$ at $p_1 = p'$, i.e., $\Delta p = 0$. This first-order condition is equivalent to $p_1^*(s) - c = 1/(2\frac{\partial \hat{x}_1(0,s)}{\partial \Delta p})$ which directly leads to (4). By symmetry, any firm $i$ could be firm 1. Finally, increasing $s$ decreases the denominator of (4) and therefore increases the maximal symmetric equilibrium markup. □

For numerical illustration of the effect of de-targeting on price-cost margins, consider the parameter constellation from Figure 1, $t = 1$, $\lambda = 2$, and $\eta = 1$. We obtain $p^*(1) = 0.4$ and $p^*(2) \approx 0.444$. Thus, advertising products from two instead of one product category increases the price by 11 percent.

Since for $s \geq 2$ the demand functions have a kink there exist multiple equilibria which can be Pareto-ranked by firms. The minimal symmetric equilibrium markup is obtained when considering a small price increase instead of a small price decrease from a symmetric price vector. In Web Appendix C, we report the minimal price equilibrium and provide a figure illustrating the full equilibrium set. In the remainder, we continue to focus on the Pareto-dominant equilibrium picked by firms at the pricing stage.

*The Advertising Strategy of the Monopoly Intermediary.* The intermediary maximizes $\beta$ (where $\beta \in (0,1)$) times the industry profits over $s$ advertised product categories. Recall that the incremental costs of adverting one additional product to all consumers are $a \geq 0$. Hence, if products of $s$ product categories are advertised to all consumers, the industry advertising costs are $2as$ and the advertising costs per firm are $(a/J)s$. Note that, from each firm $i$, the intermediary earns a profit of $\beta\pi_i = \beta[(p^*(s) - c)/(2J) - (a/J)s]$, since, by assumption, the intermediary fully passes the advertising costs on to the firm. Thus, summing over all firms, the intermediary maximizes $\beta[(p^*(s) - c) - 2as]$ over $s$. Treating $s$ as a continuous variable with $s \in [1, J]$, we obtain the following characterization of the intermediary's optimal advertising strategy.

**Proposition 2.** *In the maximal symmetric subgame perfect equilibrium, treating the number of advertised categories as a continuous variable, the intermediary posts ads with all products* *from $s^*$ product categories, where*

$$s^* = \min\{\max\{1, \frac{\sqrt{\eta(\lambda-1)t/a} - \eta(\lambda-1)}{2(\eta+1)}\}, J\}. \tag{5}$$

*Proof of Proposition 2.* The first-order necessary condition w.r.t. $s$ is equivalent to the interior solution in (5). □

Using (5), a sufficient condition for imperfect targeting such that $s^* \geq 2$, is $a \leq \frac{\eta(\lambda-1)t}{(4+\eta(\lambda+3))^2}$.

We observe that the number of advertised product categories is larger the larger the degree of product differentiation within each category. This means that our model predicts detargeting in particular for those intermediaries which carry ads for rather strongly differentiated products. In settings in which products show only a moderate degree of differentiation, category targeting is perfect. The reason is that since a higher degree of product differentiation leads to a proportionately higher markup, the profit increase due to de-targeting becomes more pronounced. This changes the balance between reduced competition and increased advertising costs when advertising more products and leads to more advertising when products are more differentiated.

Taking into account that $s$ is a discrete variable, the condition that the intermediary prefers $s = 2$ over $s = 1$, i.e., $\beta[(p^*(2) - c) - 4a] \geq \beta[(p^*(1) - c) - 2a]$, is equivalent to

$$a \leq a^c(\lambda, \eta, t) \equiv \frac{\eta(\lambda-1)t}{(2+\eta(\lambda+1))(4+\eta(\lambda+3))}.$$

The critical value $a^c(\lambda, \eta, t)$ is increasing in $\lambda > 1$. Clearly, as loss aversion becomes more pronounced, de-targeting remains the equilibrium outcome for a larger parameter value of advertising costs, $a$. In our numerical example, the critical value is $a^c(2, 1, 1) = 1/45$.

We add a remark on total welfare. Due to symmetry and full market coverage, consumers, even though they are loss averse, do not experience net losses on the equilibrium path. In addition, the equilibrium allocation of products is always efficient. The only source of inefficiency are excessive advertising costs, as some products are advertised which do not add any social value. Perfect category targeting would avoid this inefficiency, but is not chosen by the monopoly intermediary.

*Equilibrium Advertising Strategy of Competing Intermediaries.* In the case of pure Bertrand competition, in which intermediaries first set their advertising strategy and then decide which profit fraction to command, in equilibrium, one intermediary hosts all firms at zero profit. The choice of advertising strategy by intermediaries and price setting by firms are equivalent to our monopoly intermediary setting above. However, in several markets, we do not observe that one intermediary hosts all firms; our examples of hotel booking platforms and real estate agents may be cases in point. Therefore, we introduce competing intermediaries where each of the two intermediaries works for up to one firm in each product category. We continue to assume, as in the setting with a monopoly intermediary, that intermediaries obtain an exogenous fraction of profits of the firms they are contracting with. This allows us to avoid modeling the prior negotiation between intermediaries and firms.[16] The property that each intermediary serves up to one firm per product category reflects the contractual restriction to offer exclusive advertising in each product category. For example, advertising agencies work for multiple advertisers but sign a non-compete clause; i.e., they agree not to contract with advertisers who are direct competitors. As we will show, de-targeting still tends to occur in the present setting, even though competition among intermediaries mitigates de-targeting.

Intermediaries $A$ and $B$ set their advertising strategies $s_A$ and $s_B$, respectively. Thus $s_A + s_B$ is the total number of prices disclosed to each consumer. The two intermediaries split the market in the sense that in each product category $j$ the firm located at $x_j = 0$ (resp. $x_j = 1$) advertises via the first (resp. second) intermediary; i.e., each intermediary agrees to exclusively advertise at most one product within each product category. If the advertising strategies of both intermediaries mirror each other in the sense that consumers always learn both prices in a product category, then the number of categories disclosed to consumers equals $s = (s_A + s_B)/2$.[17] Solving backward, we obtain the location of the indifferent consumer and the maximal symmetric equilibrium markup of Section 4 as a function of $s = (s_A + s_B)/2$.

Formally, intermediaries $i \in \{A, B\}$ choose their advertising strategies, $\arg\max_{s_i} \beta_i[(p^*((s_A + s_B)/2) - c)/2 - s_i a]$. The first-order conditions w.r.t. $s_i$ are equivalent to

$$\frac{\partial p^*((s_i + s_{-i})/2)}{\partial s_i} = 2a.$$

Solving for the symmetric advertising equilibrium gives

$$s^{c*} = s_i^* = \frac{\sqrt{2}\sqrt{\eta(\lambda - 1)t/a} - 2\eta(\lambda - 1)}{4(\eta + 1)}, \tag{6}$$

for $a > 0$ sufficiently low. We immediately obtain that our de-targeting result under monopoly

[16]With competing intermediaries, one may expect a downward pressure on the fraction of rents absorbed by the intermediary. When this fraction is negotiated prior to the intermediaries choosing the advertising strategy, our result represents the equilibrium of the subgame after negotiation. Since the equilibrium allocation is independent of the outcome of the negotiation between firms and each intermediary (here, $\beta$ may be intermediary-specific), regarding the advertising strategy, no additional insights are gained by endogenizing the negotiation and thus the fraction $\beta$.

[17]Note that this property must be satisfied in any symmetric equilibrium when consumers observe the category an advertised price belongs to. The reason is that otherwise consumers would infer from observing only a single price of a category that this category cannot be their preferred category and ignore that category.

intermediation continues to hold with competing intermediaries.

**Proposition 3.** *Consider the model with competing intermediaries. In the maximal symmetric subgame perfect equilibrium, treating the number of advertised categories as a continuous variable, the intermediary posts ads with all products from $s^*$ product categories, where*

$$\min\{\max\{1, \frac{\sqrt{2}\sqrt{\eta(\lambda-1)t/a} - 2\eta(\lambda-1)}{4(\eta+1)}, J\}. \tag{7}$$

*This number of product categories cannot be larger than under monopoly.*

*Proof of Proposition 3.* This result follows from the exposition above and the observation that $s^{c*} = s^*/\sqrt{2} < s^*$, cf. (7). □

To summarize, duopoly intermediaries may use de-targeting (if $s^{c*} \geq 2$), but consumers will be informed about fewer products than under a monopoly intermediary. In other words, our qualitative finding of de-targeting is robust to the introduction of competition in the placement of ads between intermediaries, but the effect that consumer loss aversion generates de-targeting is mitigated.

# 5 Extensions

In the extension section, the first and second extension consider changes on the consumer side. In the first extension, we allow for heterogeneous product categories. Product categories may differ in the stand-alone utility, marginal costs, and the degree of product differentiation. Our main finding of de-targeting carries over to this more general setting. More specifically, even if two product categories are different, but the difference in marginal costs or transportation costs are not too large, the intermediary uses de-targeting and the firms in those product categories set the same price even though prices would differ across categories under perfect category targeting. In the second extension, we show that introducing loss aversion in the taste dimension does not qualitatively affect our main result.

In the third extension, we consider first another change in terms of the market structure. In the presence of a single intermediary, we postulate that there are two multi-product firms carrying one product from each category. Whether or not pricing decision are delegated to the business unit turns out to be critical as to whether our result of the base model continues to hold; de-targeting continues to hold when price setting is delegated. We then turn to a setting in which multi-product firms have information about consumers and no intermediary is present. The analysis is equivalent to the one with competing intermediaries, and our de-targeting result is confirmed when the price setting is delegated to the business units. Some of these findings can be interpreted in the context of the firm's organizational choice (centralization vs. divisionalization) and conglomerate mergers.

## 5.1 Heterogenous Product Categories

In our base model, product categories are symmetric. In this subsection, we allow for heterogeneity across categories, and show that our de-targeting result in Section 4 extends. To see this, suppose that, as in the base model, consumers observe the category an advertised product belongs to, but that there is heterogeneity across categories. We note that, since we consider full market coverage, the utility $v_j$ of two products in a category does not affect equilibrium prices, and category-specific utility differences are irrelevant. Therefore, we restrict attention to heterogeneity in marginal costs $c_j$, and heterogeneity in the product differentiation parameter $t_j$ across categories. As we will show, our analysis accommodates these asymmetries when they are not too large.

First, heterogenous marginal costs $c_j$ across categories lead to heterogenous equilibrium prices under perfect category targeting ($s = 1$). It is easy to see that these prices are given by equation (4) and are not interdependent. Under de-targeting ($s > 1$), however, price heterogeneity across categories generates additional gain-loss terms which affect the equilibrium outcome. This implies that although equilibrium markups are exactly the same across categories under perfect category targeting, they may differ under de-targeting because of price interdependencies. We further investigate this in the following. As in the main part of the paper, we consider the scenario in which the intermediary has to advertise the same number of products to all consumers. For example, this scenario is the relevant one if a website does not condition the number of advertised products on the consumer type. Such a choice may be due to design restrictions or the website's guarantee to offer a homogeneous viewing experience to all consumers.

Recall that, in the baseline model, equilibrium prices are strictly increasing in marginal costs if those are the same across categories, i.e. if $c_j = c$ for any category $j \in \{1, ..., J\}$. Additionally, if we consider the number of advertised product categories $s$ per consumer as a continuous variable, it holds that the profit-maximizing $s$ is independent of $c$, see equation (4). What are the corresponding results with heterogeneous costs across categories?

To answer this question, we have to derive consumer demand under category-specific marginal costs, i.e. $c_j \neq c_{j'}$ holds at least for some $j, j' \in \{1, ..., J\}$. Consider an infinitesimal price reduction of firm 1 in category 1 when prices are symmetric within each category outside $k = 1$. Price vector $\{p_i\}_{i \in S_1}$ is observed by consumers in category 1. Denote the set of observed categories outside $k = 1$ with a strictly lower symmetric price than $p_1$ by $L_1$ with cardinality $l_1$

and the set of observed categories outside $k = 1$ which have a weakly higher symmetric price than $p_2$ by $H_1$ with cardinality $h_1$. In the following, we will omit the category-specific index $j$ on $L$, $H$, $l$, and $h$, where unambiguous. Note that the associated advertising strategy features $s = 1 + l + h$. The indifferent consumer in category 1 obtains the following utility when buying from firm 1

$$\begin{aligned} u_1(\hat{x}_1, \{p_i\}_{i \in S_1}) =& v - t\hat{x}_1 - p_1 + \eta q_2(p_2 - p_1) + \eta \sum_{j \in H} \Big( q_{2j-1}(p_{2j-1} - p_1) + q_{2j}(p_{2j} - p_1) \Big) \\ & - \eta\lambda \sum_{j \in L} \Big( q_{2j-1}(p_1 - p_{2j-1}) + q_{2j}(p_1 - p_{2j}) \Big) \end{aligned}$$

where $q_i$ denotes the probability of buying at price $p_i$; i.e., $q_i \equiv \text{Prob}[p = p_i; \{p_i\}_{i \in S_1}]$.

The utility of the indifferent consumer of category 1 buying from firm 2 is

$$\begin{aligned} u_2(\hat{x}_1, \{p_i\}_{i \in S_1}) =& v - t(1 - \hat{x}_1) - p_2 - \eta\lambda q_1(p_2 - p_1) + \eta \sum_{j \in H} \Big( q_{2j-1}(p_{2j-1} - p_2) + q_{2j}(p_{2j} - p_2) \Big) \\ & - \eta\lambda \sum_{j \in L} \Big( q_{2j-1}(p_2 - p_{2j-1}) + q_{2j}(p_2 - p_{2j}) \Big). \end{aligned}$$

Since, in consumer's personal equilibrium, $q_1 = \hat{x}_1/s$, $q_2 = (1 - \hat{x}_1)/s$, and $q_i = 1/(2s)$ for $i > 2$, the utility difference $\Delta u(\hat{x}_1, \{p_i\}_{i \in S_1}) \equiv u_1(\hat{x}_1, \{p_i\}_{i \in S_1}) - u_2(\hat{x}_1, \{p_i\}_{i \in S_1})$ can be rewritten as

$$\Delta u(\hat{x}_1, \{p_i\}_{i \in S_1}) = \left(1 + \eta \cdot \frac{h + (1 - \hat{x}_1)}{s} + \eta\lambda \cdot \frac{l + \hat{x}_1}{s}\right)(p_2 - p_1) - t(2\hat{x}_1 - 1), \tag{8}$$

based on the observation that the price comparisons of $p_1$ and $p_2$ with prices outside category 1 partially cancel out. The utility difference only depends on the price difference in category 1 as well as on the number $h$ and $l$ of more and less expensive categories than category 1 in consideration set $S_1$. If the number of less expensive categories is zero, i.e. $l = 0$ and $h = s - 1$, then the utility difference is identical to that in equation (3). This implies that with category-specific symmetric prices only the demand of the consumers in the least expensive categorie(s) is identical to that when all products had the same price as that category, while demand in all categories $j$ with strictly higher marginal costs is different compared to demand which would prevail if the same price $p_{2j}$ applied to all products in $S_j$. One could be concerned that this threatens the general robustness of our de-targeting result. As we show next, this deserves careful consideration, but our de-targeting result is robust to any sufficiently small heterogeneity in category-specific marginal costs; this finding easily extends to heterogeneity in category-specific transportation costs $t_j$, as we will see further below.

Analogous to Section 4, from $\Delta u(\hat{x}_1, \{p_i\}_{i \in S_1}) = 0$, the location of the indifferent consumers and firms' demand can be derived.

**Lemma 2.** *Suppose that prices are category-specific but symmetric within each category outside category* 1*. In particular, suppose that* $\Delta p \equiv p_2 - p_1 \geq 0$ *and* $0 < p_{2j-1} = p_{2j} \leq p_1 < p_2 \leq p_{2j'-1} = p_{2j'}$ *with* $j, j' \in \{1, ..., J\}$*. Then, the indifferent consumers in the different categories are located at*

$$\hat{x}_1(\Delta p, s, l_1) = \min\{\frac{l_1\eta(\lambda-1)\Delta p + s(t + (1+\eta)\Delta p)}{2st - \eta(\lambda-1)\Delta p}, 1\}, \tag{9}$$

*and* $\hat{x}_j(p_{2j} - p_{2j-1}, s, l_j) = 1/2$ *for all* $j \in \{2, ..., J\}$*, where* $l_j$ *is the number of observed categories outside* $j$ *which have a strictly lower prices than those in category* $j$*. The demand of firm* $2j-1$ *and* $2j$ *are given by* $D_{2j-1}(p_{2j} - p_{2j-1}, s) = 1 - D_{2j}(p_{2j} - p_{2j-1}, s) = \hat{x}_j(p_{2j} - p_{2j-1}, s, l_j)/J$ *for all* $j \in \{1, ..., J\}$*.*

*Proof of Lemma 2.* The proof is analogous to that of Lemma 1, specifically using (8) and that $h = s - 1 - l$. □

It is easy to verify that when category 1 is not the least expensive category in the consideration set $S_1$, i.e. $l_1 > 0$, then the demand of firm 1 differs from that under fully symmetric categories. More precisley, the demand of firm 1 is more price sensitive than with fully symmetric prices because its demand under fully symmetric categories is augmented by the additional term $l_1\eta(\lambda-1)\Delta p$ in the numerator, see (9).

Without loss of generality, we relabel product categories such that category-specific marginal costs $c_j$ are weakly increasing in $j \in \{1, ..., J\}$. Let $\mathbf{p}^*$ be a candidate maximal equilibrium price vector with the symmetric prices $p^*_{2j-1} = p^*_{2j}$ within categories maintaining this ordering. For $s = 1$, $\mathbf{p}^*$ can simply be derived by using category-specific demand as in Section 4. $\mathbf{p}^*$ is then characterized by $p^*_{2j-1} = p^*_{2j}$ as shown in (4) with $c = c_j$. This equilibrium implying perfect targeting always exits. For $s > 1$, $p^*_{2j-1} = p^*_{2j}$, however, also depend on the rank of category $j$ within $\mathbf{p}^*$. Using category-specific demand as in (9), the following candidate for a category-specific maximal symmetric equilibrium price can be derived.

$$p^*_{2j-1}(s, l_j, c_j) = p^*_{2j}(s, l_j, c_j) = \frac{2t}{2(1+\eta) + \frac{(1+2l_j)\eta(\lambda-1)}{s}} + c_j, \quad j \in \{1, ..., J\}. \tag{10}$$

Note that $p^*_{2j-1}(s, l_j, c_j)$ is increasing in $s$ but decreasing in $l_j$. We show next that for small differences in marginal costs, $\mathbf{p}^*$ does not constitute a price equilibrium. Assume that the difference in marginal costs is non-zero at the top, i.e., $c_{J-1} < c_J$. Then, at least for the category with the highest marginal costs $c_J$, it holds that $l_J = s - 1$. This implies that by adding categories to each consideration set (i.e., increasing $s$) also $l_J$ must increase. As noted above, since $p^*_{2J-1}(s, l_J, c_J)$ is decreasing in $l_J$, this expression must be increasing less when adding additional categories to each consideration set than the corresponding expression for categories $j < J$, which have lower marginal costs. The reason is that for those categories, increasing the consideration set may include products with higher prices (this is necessarily the case for $j = 1$). If the difference in marginal costs with the next lower category $J - 1$ is sufficiently small, then (10) implies that $p^*_{2J-1}(s, l_J, c_J)$ must be lower than $p^*_{2J-3}(s, l_{J-1}, c_{J-1})$ because $l_J - l_{J-1} = 1$ but $c_J - c_{J-1}$ may be arbitrarily small. This violates the ordering of $\mathbf{p}^*$ and therefore constitutes a contradiction to $\mathbf{p}^*$ being a category-specific maximal symmetric price equilibrium. While this argument has ruled out an equilibrium with category-specific prices, it does not imply the non-existence of an equilibrium with symmetric prices in each product category.

As the next proposition establishes, for categories with sufficiently small differences in marginal costs, a focal price equilibrium with de-targeting exists and is selected by profit dominance, confirming our de-targeting results for category-specific marginal costs. In this equilibrium, for any pair of firms belonging to the same consideration set $S_j$ for some category $j$, prices are the same, even though their marginal costs are category specific. This implies that de-targeting here features heterogeneous price-cost margins in contrast to what would happen under perfect category targeting. Our argument relies on the multiplicity of symmetric price equilibria in our setup as characterized by the equilibrium price correspondence in Figure 2 in Web Appendix C. For expositional clarity, the proposition only allows for two categories; it can be extended to any finite number of categories taking the particular structure of heterogeneity across categories into account.

**Proposition 4.** *Suppose that there are two product categories and* $0 < c_2 - c_1 \leq \Delta c_1^{crit}$, *where*

$$\Delta c_1^{crit} \equiv \frac{2(\lambda - 1)\eta t}{(\lambda\eta + \eta + 2)((\lambda + 3)\eta + 4)}. \tag{11}$$

*Let advertising costs be sufficiently low such that* $s = 2$ *would be optimal if both categories had marginal costs* $c_1$. *Then, the maximal equilibrium prices equal*

$$p^*_{2j-1} = p^*_{2j} = p^*_1(s = 2, l_1 = 0, c_1), \quad j \in \{1, 2\}, \tag{12}$$

*where* $p^*_1(s = 2, l_1 = 0, c_1)$ *is given by* (10) *with* $l_1 = 0$ *which is equivalent to* (4).

*Proof of Proposition 4.* First note that since products in category 1 are less costly, by Section 4, $p^*_1(s = 2, l_1 = 0, c_1)$ is the category-specific candidate for a profit-maximizing equilibrium price for firms in category 1. Here, $s^* = 2$ implies de-targeting. Second note that as long as the perfect targeting equilibrium price in category 2, $p^*_3(s = 1, l_2 = 0, c_2)$ is not larger than $p^*_1(s = 2, l_1 = 0, c_1)$, then de-targeting at price $p^*_1(s = 2, l_1 = 0, c_1)$ is also strictly preferred to perfect category targeting by firms in category 2. Since $p_3^*(s,0,c_2)$ by construction is larger than $p_1^*(s,0,c_1)$ for any $s$ (considering $s$ as a continuous variable) by $\Delta c$, the two equilibrium price correspondences in $s$ in category 1 and 2 overlap only on $[p_3^{*-}(s,0,c_2), p_1^*(s,0,c_1)]$ given that this set is non-empty.[18] This implies that $p_1^*(s=2,0,c_1)$ is element of this overlap if this overlap is non-empty. Since at $p_1^*(s=2,0,c_1)$ all prices are identical, also in category 2 it holds that $l_2=0$ and the demand from Section 4 applies. $p_1^*(s=2,0,c_1)$ then is an element of the $l_2=0$-equilibrium correspondence in category 2 at $s=2$, i.e. $p_1^*(s=2,0,c_1) \in [p_3^{*-}(s=2,0,c_2), p_3^*(s=2,0,c_2)]$ if $p_1^*(s=2,0,c_1) \geq p_3^{*-}(s=2,0,c_2)$ (this is the necessary condition for equilibrium existence). Finally, it can be shown that $p_3^*(s=1,0,c_2) \leq p_1^*(s=2,0,c_1)$ (profit dominance of the equilibrium) is equivalent to $c_2-c_1 \leq \Delta c_1^{crit}$. Furthermore, it is easy to show that $c_2-c_1 \leq \Delta c_1^{crit}$ implies $p_1^*(s=2,0,c_1) \geq p_3^{*-}(s=2,0,c_2)$ (equilibrium existence). This completes the proof. □

In Proposition 4, $s^*=2$ constitutes de-targeting. Thus, our de-targeting result is robust to sufficiently small differences in marginal costs. Conceptually, it is interesting to note that Proposition 4 presents a focal price equilibrium with one symmetric price across heterogenous categories. This is in contrast to the existing literature, where focal price equilibria are only predicted under a different timing as in Heidhues and Kőszegi (2008) with prices being unobserved at the moment of reference point formation. Note further that $c_2-c_1 \leq \Delta c_1^{crit}$ is a sufficient condition for profit dominance of the focal price equilibrium $p_1^*(s=2,l_1=0,c_1)$. A necessary condition for its existence is that the two equilibrium price correspondences in $s$ in category 1 and 2 overlap at $s=2$, i.e. $p_1^*(s=2,0,c_1) \geq p_3^{*-}(s=2,0,c_2)$, where $p_3^{*-}(s,0,c_2)$ constitutes the minimal symmetric equilibrium price as described in (21) in Web Appendix C which describes the lower bound of the equilibrium price correspondences in $s$ in category 2. This is equivalent to $c_2-c_1 \leq \Delta c_2^{crit}$, where

$$\Delta c_2^{crit} \equiv \frac{8(\lambda-1)\eta t}{(3\lambda\eta+\eta+4)((\lambda+3)\eta+4)}. \tag{13}$$

Note that $\Delta c_2^{crit} > \Delta c_1^{crit}$. For $c_2-c_1 \in (\Delta c_1^{crit}, \Delta c_2^{crit}]$, the refinement of profit dominance might not generically select the focal price equilibrium $p_1^*(s=2,l_1=0,c_1)$ but the perfect targeting equilibrium or the category-specific maximal symmetric price equilibrium with de-targeting if the latter exists. The category-specific maximal symmetric price equilibrium with de-targeting is characterised by symmetric prices $p_1^*(2,0,c_1)$ in category 1 and symmetric prices $p_3^*(2,1,c_2)$ in category 2, cf. (10). This equilibrium exists if $p_3^*(2,1,c_2) > p_1^*(2,0,c_1)$ which is equivalent

[18] Note that $p_3^{*-}(s,0,c_2)$ constitutes the minimal symmetric equilibrium price as described in (21) in Web Appendix C which describes the lower bound of the equilibrium price correspondences in $s$ in category 2.

to $c_2 - c_1 > \Delta c_3^{crit}$, where

$$\Delta c_3^{crit} \equiv \frac{8(\lambda - 1)\eta t}{(3\lambda\eta + \eta + 4)((\lambda + 3)\eta + 4)}. \tag{14}$$

In the special case that $J = 2$, $\Delta c_2^{crit}$ and $\Delta c_3^{crit}$ coincide. This implies that, for $J = 2$, the focal price equilibrium with de-targeting and the category-specific maximal symmetric price equilibrium with de-targeting are mutually exclusive. For $J = 2$, it can be shown that also for $c_2 - c_1 > \Delta c_1^{crit}$, de-targeting always generates higher industry profits than perfect category targeting and thus will be implemented by the intermediary for sufficiently low advertising costs. However, profit dominance of equilibria which induce de-targeting may be lost when we allow for more than two categories.

Second, a similar argument applies when considering heterogeneity in the product differentiation parameter $t_j$ across categories. Unlike with category-specific marginal costs, here the category with the higher transportation costs $t$ also has the higher markup under perfect targeting. De-targeting has then a more negative effect on the price of that category than under category-specific marginal costs. Lemma 2 continues to hold, and the analogue of Proposition 4 applies for sufficiently low $\Delta t$, i.e. $t_2 \in (t_1, t^{crit_1} \cdot t_1]$, where

$$t^{crit_1} \equiv \frac{2(\lambda\eta + \eta + 2)}{(\lambda + 3)\eta + 4}. \tag{15}$$

However, for large differences in transportation costs, i.e. $t_2 > t^{crit_1} \cdot t_1$, de-targeting may always be dominated by perfect category targeting (including for $J = 2$). This implies that in an environment with more than two product categories, the intermediary only wants to include products from categories with similar markups in the set it advertises to consumers. The availability of such similar categories then determines the advertising strategy and thus the degree of de-targeting.

We end this subsection by adding two remarks about what happens (1) if the intermediary can condition its advertising strategy on the observed consumer type and (2) if there is also marginal cost heterogeneity within product categories.

Consider now the alternative scenario in which the intermediary can condition the number of advertised product categories $s_k$ on the particular product category $k$ a consumer is interested in. An example for such an intermediary is a search engine providing sponsored links when the number of links is conditioned on a consumer's preferred product category. Such conditioning tends to makes some de-targeting easier to support, as the intermediary can group similar product categories together with de-targeting, while it can use perfect category targeting for those categories that are very different from all others (in terms of marginal costs or transportation costs). More generally, the intermediary optimally advertises different numbers of product categories depending on the product category a consumer likes.

A different de-targeting result arises under heterogeneity of marginal costs within and across categories. Asymmetric marginal costs within categories lead to an asymmetric price equilibrium whose calculation is computationally demanding. For simplicity, consider a situation in which categories can be ranked by marginal costs, but in which all but the most costly category are symmetric. In such a situation, the disadvantage of de-targeting in case of the most costly category is mitigate by the cost asymmetries between firms. That is, if the cost asymmetry is sufficiently large, firms in that product category actually benefit from de-targeting. The reason is related to the result of Karle and Peitz (2014) that under consumer loss aversion, cost asymmetries make competition between duopolists more intense. Therefore, for sufficiently large cost asymmetries in the high-cost category, adding products with lower prices to the consideration set reduces the intensity of price competition in that category and renders de-targeting profitable.

## 5.2 Loss Aversion in the Taste Dimension

In this subsection, we show that allowing for loss aversion in taste does not affect our de-targeting result. In fact, loss aversion in taste simply reduces the price sensitivity of consumers in each category and therefore increases the level of equilibrium prices (anti-competitive effect); cf. Karle and Peitz (2014) for a more general analysis of the competitive effects of loss aversion in the price and taste dimension under imperfect competition.

For any category $k$, the reference-point distribution with respect to the match value refers to the reservation value $v$ minus the distance between ideal and actual product variety, $d \in [0, 1]$, times the taste parameter $t$. The density of the probability distribution of the distance is denoted by $g(d) = Prob(|x - y_\sigma| = d)$, where the location of the firm is $(y_\sigma, k)$ with $y_\sigma \in \{0, 1\}$, and the purchase strategy in personal equilibrium for a consumer of type $(x, k)$ is $\sigma = \sigma(x, k; \{p_i\}_{i \in S_k})$.[19] The corresponding cumulative distribution function is denoted by $G(d)$.

Consider the case in which in category 1, $\hat{x}_1 \geq 1/2$; i.e., $p_1 \leq p'$ so that firm 1 has a weakly larger market share than firm 2, whereas in all other categories prices are equal to $p'$ such that $\hat{x}_{j \neq 1} = 1/2$. Because, at $p_1 \leq p'$, some consumers will not buy from their nearest firm, $g(d)$ is a step function with support $[0, \hat{x}_1]$. The discontinuity of $g$ on $(0, \hat{x}_1)$ can be determined as follows. The smallest critical taste distance in all $s$ categories which consumers in category 1 observe is between $x = \hat{x}_1$ and firm 2. It is equal to $d = 1 - \hat{x}_1$. At this distance, all consumers

[19]$\sigma$ is a function of observed prices and the consumer's location $(x, k)$ conditional on the consumer's expectation about equilibrium outcomes that are incorporated in their two-dimensional reference-point distribution. $\sigma$ states a consumer's personal equilibrium strategy according to Kőszegi and Rabin, 2006.

buy their nearest product. The next larger critical taste distance is the one in categories with symmetric prices. It is equal to $d = 1/2$. At this distance, all consumers except the ones close to firm 2 buy their nearest product. Finally, only the consumers that will be attracted by firm 1 ex post experience up to the maximum critical taste distance which is $\hat{x}_1$. Hence, the density function takes the form

$$g(d) = \begin{cases} 2 & \text{if } d \in [0, 1-\hat{x}_1] \\ 2\frac{2s-1}{2s} & \text{if } d \in (1-\hat{x}_1, 1/2] \\ 2\frac{1}{2s} & \text{if } d \in (1/2, \hat{x}_1] \\ 0 & \text{otherwise.} \end{cases}$$

After inspection, consumers experience a gain-loss utility in the price and the taste dimension (universal gain-loss function according to Kőszegi and Rabin, 2006). That is, the reference-point distribution is split up for each dimension at the value of realization in a loss part with weight $\lambda > 1$ and a gain part with weight 1. In the loss part, the realized value is compared to the lower tail of the reference-point distribution; in the gain part, it is compared to the upper tail of the reference-point distribution. For $p_1 \leq p'$ and $\mathbf{p} = (p_1, p', ..., p')$, the utility of a category-1 consumer with $x \in (1/2, \hat{x}_1]$ purchasing product 1 is then given by

$$\begin{aligned} \tilde{u}_1(x, \{p_i\}_{i\in S_1}) = & v - tx - p_1 + \eta(1 - \text{Prob}[p = p_1; \{p_i\}_{i\in S_1}])(p' - p_1) \\ & - \eta\lambda \cdot t \int_0^x (x - \tilde{d}) dG(\tilde{d}) + \eta \cdot t \int_x^{\hat{x}_1} (\tilde{d} - x) dG(\tilde{d}). \end{aligned}$$

The last two terms correspond to the loss (gain) from not experiencing a smaller (larger) distance in the taste dimension than $x$. Analogously, a consumer's utility from a purchase of product 2 is given by

$$\begin{aligned} \tilde{u}_2(x, \{p_i\}_{i\in S_1}) = & v - t(1-x) - p' - \eta\lambda \cdot \text{Prob}[p = p_1; \{p_i\}_{i\in S_1}](p' - p_1) \\ & - \eta\lambda \cdot t \int_0^{1-x} ((1-x) - \tilde{d}) dG(\tilde{d}) + \eta \cdot t \int_{1-x}^{\hat{x}_1} (\tilde{d} - (1-x)) dG(\tilde{d}). \end{aligned}$$

This allows us to solve a consumer's personal equilibrium by determining the location of the indifferent consumer $\hat{x}_1$ which is implicitly given by $\tilde{u}_1(\hat{x}_1, \{p_i\}_{i\in S_1}) = \tilde{u}_2(\hat{x}_1, \{p_i\}_{i\in S_1})$. Lemma 3, which is relegated to Appendix A, characterizes the location of the indifferent consumer $\hat{x}_1$ and firms' demand when consumers are loss averse in the price and the taste dimension.

For any given $s$ solving the pricing game gives the following equilibrium markup.

**Proposition 5.** *The maximal symmetric equilibrium markup is given by*

$$\tilde{p}_i^*(s) - c = \frac{2t(\eta\lambda + 1)}{2(1+\eta) + \frac{\eta(\lambda-1)}{s}}, \quad i \in \{1, ..., 2J\}.$$

*It is strictly increasing in the number $s \in \{1, ..., J\}$ of product categories disclosed to each consumer.*

For any given $s$, comparing this equilibrium markup to the one in the base model, we observe that the markup is scaled up by the factor $(\eta\lambda + 1)$. While this affects the optimal advertising strategy, our qualitative insights are unaffected. In particular, the condition for the intermediary to advertise products from two instead of one product category and, thus, engage in de-targeting, can be written as

$$2a \leq \frac{2t(\eta\lambda + 1)}{2(1+\eta) + \frac{\eta(\lambda-1)}{2}} - \frac{2t(\eta\lambda + 1)}{2(1+\eta) + \eta(\lambda - 1)}$$

which is equivalent to

$$a \leq \tilde{a}^c(\lambda, \eta) \equiv (\eta\lambda + 1)\frac{t\eta(\lambda - 1)}{(2 + \eta(\lambda + 1))(4 + \eta(\lambda + 3))}.$$

Since $(\eta\lambda + 1) > 1$, de-targeting occurs for a larger range of values of $a$ when consumers are loss averse also in the taste dimension.

## 5.3 Multi-Product Firms

In this subsection, we extend the analysis to allow for multi-product firms. In particular, we consider multi-product duopolists each of which is offering one product within each product category. Whether our results from the base model carry over depends on the way in which these multi-product firms are organized.

First, we show that our de-targeting result does not carry forward to the case where two centralized multi-product firms sell one product in each category respectively. Suppose that, in category 1, multi-product firm A sets the price $p_1 < p'$ and multi-product firm B sets the price $p'$. Then, as in Section 4, the location of the indifferent consumer in category $k = 1$, has the same structure as equation (3). However, $\text{Prob}[p = p_1; \{p_i\}_{i \in S_1}]$, in general, takes a different value because the deviation of a multi-product firm allows for price deviations in more than one category. The most profitable downward deviation of a centralized multi-product firm involves the same price deviation in all product categories. Therefore, $\mathbf{p} = (p_1, p', p_1, p', ..., p_1, p')$. No matter what is the preferred product category, consumers will always have the choice between one product at price $p_1$ and the other at price $p'$. It follows that the probability to purchase at price $p_1$ is $\text{Prob}[p = p_1; \{p_i\}_{i \in S_1}] = \hat{x}_1$. Note that this purchase probability and the location of the indifferent consumer in category 1, $\hat{x}_1$, do not depend on the number of product categories disclosed to consumers in category 1 (and $\hat{x}_1 = \hat{x}_k$ for all advertised categories). Thus, de-targeting is competitively neutral, and, in symmetric equilibrium, the centralized multi-product firms will use perfect category targeting ($s = 1$) and set a price $p^*(1)$ as shown in (4) in all product categories.

Second, we show that our results of the base model continue to hold in a setup with decentralized multi-product firms which delegate price setting to a business unit in each category respectively. Suppose each business unit maximizes own profits. In other words, the firm has chosen divisionalization, and each business unit operates as a profit center. In this setup, a coordinated downward price deviation by all business units of one multi-product firm is not possible. Therefore, the relevant price vector to identify the location of the indifferent consumer is equal to $\mathbf{p} = (p_1, p', ..., p')$. The implied demand for a business unit is identical to that of a single-product firm as in Section 4. This implies that our de-targeting result carries over to this setup.[20] Also a combination of one decentralized multi-product firm with $J$ products and $J$ single-product firms leads to the same result. De-targeting coordinated by the intermediary is optimal as long as no centralized multi-product firm is present in the market.

Third, consider a market without any intermediary, where multi-product firms now choose the advertising strategy. More specifically, price setting is delegated to the category level, but the choice of advertising strategy is made by each headquarter. Firms are assumed to be fully informed about consumers' preferred category. In this setting we predict a reduced but positive level of de-targeting when firms choose their strategies independently of each other. The formal analysis is equivalent to that of competing intermediaries in Section 4.

A number of observations follow from these results. Consider a firm's organizational choice and, in particular, its divisionalization decision.[21] It is optimal for multi-product firms to choose divisionalization with the following feature: The choice of advertising strategy is centralized at the headquarter, but the pricing decision is decentralized to each business unit which, in turn, maximizes its own profit. Thus, our model identifies consumer loss aversion as the driving force of the organizational choice; absent consumer loss aversion the organizational choice would be indeterminate.

Considering mergers, we call the change from $J$ single-product firms to a multi-product firm a conglomerate merger.[22] With loss-averse consumers, a conglomerate merger might not

[20] Because of our assumption of full market coverage this result also holds in the setup with decentralized multi-product firms when single-product business units set their price to maximize overall firm profit.

[21] In this sense, our paper provides a novel contribution to the short literature on divisionalization; papers in that literature include Baye et al. (1996) and Gonzalez-Maestre (2000).

[22] Therefore, our paper can also be seen as a contribution to the literature on conglomerate mergers. The finance

be neutral to profits. If pricing remains decentralized after the merger, profits per product do not change. If, however, pricing is centralized, then profits are reduced, and consumer loss aversion reduces the incentive to form conglomerate mergers.

# 6 Discussion

Several concerns about the generality of our result may remain.

*Strategy of the intermediary: fee setting instead of profit sharing.* A first concern may be that our main result critically relies on the assumption that the intermediary absorbs an exogenous fraction of industry profits. Consider now an environment where advertising firms have to pay a fee to the intermediary on top of the advertising costs which are paid for by the firms in any case. Clearly, if a monopoly intermediary sets a fee for advertising a product, it will be able to extract the full industry profit, and advertising strategy and firm pricing remain unaffected (selecting the equilibrium of the pricing game of the firms that obtains in the limit as $\beta$ turns to 1); thus our result continues to hold. Consider now the other extreme that firms can jointly make a take-it-or-leave-it offer on how much to pay for advertising; i.e., they set a uniform fee, after the intermediary has decided on its advertising strategy (with the option to withdraw if ex post the participation constraint is violated). Provided that the fee is such that both firms within the category advertise, our main result is also confirmed in this case.

When do firms jointly decide on a fee that they all have to pay? Consider any given ad strategy $s$. There are two equilibrium candidates for the fee offered by the firms. First, it may be optimal for them to agree to pay a fee equal to zero. Then both firms within each product category will decide to advertise. Industry profits net of the advertising fee are $2\pi^d$. Alternatively, firms may agree to fix the fee such that only one firm per category advertises. This requires the fee to be at least $\pi^d$, and, thus, firms would set the fee equal to $\pi^d$. Hence, maximal industry profits net of the advertising fee that achieves monopoly in each product category is $\pi^m - \pi^d$, as the monopoly firm pays the fee $\pi^d$. Under the veil of ignorance who will be the active firm in the latter case, firms maximize the sum of firm profits. They prefer the arrangement with monopoly in each product category if the firms' duopoly profits $2\pi^d$ are less than monopoly profits at the higher fee $\pi^m - \pi^d$; this is equivalent to $3\pi^d < \pi^m$. If this inequality holds, despite giving all the bargaining power to the firms, the intermediary would make a strictly positive profit, and would choose perfect targeting because firms will be in a

literature provides a theory of conglomerate mergers based on improved financing possibilities; e.g. Lewellen (1971) argues that a conglomerate merger benefits from increased borrowing capacity. Recent work in industrial organization (Chen and Rey, 2015) provides a theory of conglomerate mergers exploring the competitive effects when consumers are one-stop shoppers.

monopoly position in each category.[23] We note that the condition $3\pi^d < \pi^m$ implies $2\pi^d < \pi^m$, which has been assumed to hold in our base model. This implies that duopoly competition will result under a wider set of circumstances, and our de-targeting result is not only robust to allowing firms to collectively set the advertising fee, but applies more broadly, as it is not necessary to assume that duopoly industry profits exceed monopoly industry profits, in contrast to the base model.

*Impossibility of perfect category targeting.* A second concern may be that our main result critically relies on our assumption that the intermediary can perfectly identify the product category a consumer is interested in; i.e., consumer recognition is perfect. De-targeting in our base model has the property that some products are advertised to a consumer that this consumer is never going to buy. While this served well to communicate our result, this property may be seen as unrealistic. Suppose instead that the intermediary can only identify the consumer's preferred category with probability $1 - \varepsilon$ and wrongly assigns a different category with probability $\varepsilon$. For illustration, suppose that there are, in total, two product categories. Advertising all four products then leads to a purchase with probability 1, whereas category targeting leads to a purchase probability of $1 - \varepsilon$. The intermediary continues to use category targeting if the associated advertising costs $2a$ exceed additional industry profits $2\varepsilon\pi^d$ from advertising all products to each consumer, where $\pi^d$ is the Hotelling duopoly profit of a firm. Suppose that this condition holds absent consumer loss aversion.

Since consumer loss aversion leads to higher duopoly profits under de-targeting than under category targeting, the change in industry profits from de-targeting (together with the additional reach of advertising) may well exceed the associated advertising costs when consumer are loss averse. Hence, even if the intermediary cannot perfectly identify the consumer's preferred product category, it may choose de-targeting when consumer are loss averse, while it would choose perfect category targeting absent consumer loss aversion. Here, under consumer loss aversion, each advertised product generates positive expected sales from each consumer. The equilibrium has the feature that the expected sales do not cover associated advertising costs for some ads. Such an advertising strategy is nevertheless optimal because of the increased margin on products in the other product category. To summarize, our main result that consumer loss aversion drives de-targeting generalizes to markets in which advertising products outside the allegedly preferred product category increases overall demand.

*Ex ante unobservability of product category.* A third concern may be that our assumption on the ex ante observability of product category limits the applicability of our analysis. More concretely, we assumed that consumers can identify which products belong to any category,

[23]We show in Appendix D that perfect targeting in each category is indeed optimal when there is only one active firm per category.

but cannot ascertain before inspection which product category they like. Consider then the situation that consumers only observe the number of posted products (which, for simplicity, are assumed to be an even number) and their prices prior to forming their reference point. While, in general, demand functions are different from the ones used in this paper, the demand functions coincide in situations in which all but one firm set the same price.

In the formal analysis in the base model, when products from $s$ categories are announced, consumers believe that they are going to be interested in the product category in which one firm sets a lower price with probability $1/s$. Within this category (say, category 1) consumers expect to buy product 1 with probability $\hat{x}_1$. If product 1 is the lower-priced product, the overall prior expected purchase probability of the lower priced product is $\hat{x}_1/s$.

By contrast, when consumers do not observe product categories, but observe one product with a lower price than all others, they expect that this product is with probability $1/s$ from their preferred product category. In addition, they (correctly) expect that the other product from this category is also advertised. Therefore, they correctly infer that they will buy the lower-priced product with probability $\hat{x}_1/s$, which is the same as in the base model.

Hence, demand functions for price vectors with an even number of products and up to one price being below the price charged by all other firms are the same, and the equilibrium analysis in both models is the same. Consequently, our result on de-targeting carries over to the setting in which consumers do not initially observe product categories.[24]

*Conditioning reference prices on preferred product category.* A fourth concern may be that consumers may condition reference prices on the category they like. Since consumers identify the category a product belongs to and know that they are interested only in one category, they may realize only gains or losses for price differences within a product category. According to this alternative specification, consumers only experience gains and losses conditional on making them in the category they like. To illustrate, consider a setting with two product categories with prices $p_1$ and $p'$ in category 1 (with $p_1 < p'$) and $p'$ for both products in category 2. After the contact stage the consumer learns that she likes category $k$. If only the products in this category are advertised to her, nothing changes. If, however, a consumer who likes category 1 sees all products, she will reason that with probability $1/2$ she would have liked the other category, in which case she would not make any gains or losses. If she buys product 1, she expected to like category $k$ with probability $1/2$ in which case she enjoys a gain of $\eta(p'-p_1)$ with probability $(1-\hat{x}_1)$. Thus, her gain is $\eta(1-\hat{x}_1)(p'-p_1)/2$. Similarly, if she buys product 2, she experiences a loss of $\eta\lambda(1-\hat{x}_1)(p'-p_1)/2$. While expressions are different from

[24]Relaxing the assumption that only an even number of products can be advertised, we would obtain a finer strategy space of the intermediary, but our qualitative findings still hold and de-targeting obtains on a larger set of parameter values.

our base model, our qualitative finding of de-targeting is confirmed. More specifically, when introducing asymmetric product categories, an intermediary who uses de-targeting does not need to worry about which categories to include, and equilibrium prices differ across categories for different marginal cost or different transportation cost parameters. Thus, this alternative setting is compatible with disclosing different prices to consumers. Furthermore, an extension to include asymmetries in each product category is straightforward, giving rise to different prices within and across product categories. Thus, this modified model generates de-targeting and different prices among the products advertised to a given consumer.

*Key assumptions.* Our result is robust to the above variations, but it is essential for our result that prices are observed by consumers prior to forming their reference points, whereas the match between product and tastes is not. If consumers were not able to observe price prior to forming their reference points, consumers would not observe price deviations and believe that all firms set the symmetric equilibrium price with probability 1 (this alternative timing has been proposed by Heidhues and Kőszegi, 2008). Hence, if a firm deviates by setting a lower price and a consumer considers buying that product she experiences a gain with probability 1 independent of the number of products that are advertised; there is neither a gain nor a loss for all other products. Consequently, equilibrium prices are independent of the number of advertised products and, to avoid larger advertising costs, the intermediary will always choose perfect category targeting.

If the intermediary could inform consumers about the exact match between product and tastes and did so, it would constitute perfectly informative content advertising,[25] and consumers would not face uncertainty as they observed price as well as match value prior to forming their reference points. Thus, consumers would have deterministic reference points and experience neither gains nor losses (for any number of advertised products and prices) which implies that consumers behave as if they experienced intrinsic utility only. Perfectly informative content advertising therefore leads to higher prices on the equilibrium path than not revealing match information (cf. equation (4) with $\eta > 0$ vs. $\eta = 0$), and the number of advertised products does not affect equilibrium prices. For this reason, the intermediary will always choose perfectly informative content advertising (and, when advertising is costly, only advertise the best match). In this paper, this is ruled out by assuming that the intermediary can identify a consumer's preferred product category but never her preferred product (and it cannot provide information that would allow consumers to do so).

[25] For a formal analysis of informative content advertising in a monopoly setting, see Anderson and Renault (2006) considering standard consumers and Karle (2013) considering expectation-based loss-averse consumers.

# 7 Conclusion

Targeted advertising allows advertisers to save on advertising costs without foregoing profitable consumer segments. Recently, we observe a lot of targeted advertising on the internet. However, given the amount of personal data available to large internet portals, based on casual evidence, it may be surprising how badly advertising is sometimes targeted. This could happen when internet portals are not very good at making use of their data. More interestingly, it may happen on purpose. The literature has so far identified two explanations why internet portals may deliberately add "noise"; i.e., engage in de-targeting. First, consumers may react negatively to targeted advertising due to privacy concerns; second, when consumers search sequentially for products, an internet portal may want to add noise to relax competition between advertising firms. This paper advances a new explanation based on a new trade-off that arises when loss-averse consumers use reference pricing. Here, de-targeting affects the gain-loss utility of consumers and thereby reduces the price elasticity of the firms' demand. It thus relaxes price competition between firms.

We consider a parsimonious model of product market competition in which there are several product categories and there is imperfect competition between firms within each product category.[26] Consumers have unit demand and derive positive utility from a product in their preferred category and zero utility in all other categories. Due to customer recognition, an intermediary is able to identify a consumer's preferred category. However, to steer the firms' pricing incentives it may want to advertise products out of the consumer's preferred set.

The economic mechanism works as follows. Consumers infer purchasing probabilities from prices and product offerings. This affects the pricing incentives of firms when consumers are expectation-based loss averse and use reference prices. In particular, an increase in the number of listings affects profits at the margin when a firm decreases its price. By posting more ads, the intermediary can reduce the price elasticity of demand for each product it advertises. As long as it participates in the associated rise in industry profits, the intermediary has an incentive to include ads from ex post irrevelant product categories and balances the trade-off between relaxed competition and higher advertising costs to determine its optimal advertising strategy. When advertising costs are not too high, this strategy involves some de-targeting and thus differs drastically from the profit-maximizing advertising strategy if consumers are *not* loss-averse.

In our analysis, we tied our hands by assuming that consumers are expectation-based loss-

[26]For convenience, we assumed Hotelling duopoly competition in each product category. This provides a simple tractable setting. However, our insights generalize, for instance, to a model with more than two firms within each product segment who compete on a Salop circle. We also expect them to hold in other discrete-choice settings such as the logit model.

averse. This uniquely pinned down the reference-point distribution of consumers based on rational expectations about their purchase behavior. If consumers did not form rational expectations – as considered in the marketing literature (for example, Rajendran and Tellis, 1994) – we would need to motivate the reference-point distribution from outside the model. For example, consumers expect to buy each advertised product with the same probability independent of price. In this case, our economic mechanism continues to apply and due to reference pricing, de-targeting still increases industry profits.

We also endowed consumers with all abilities to make inferences from observed products and prices on purchase probabilities. To see that full inference limits our de-targeting result, consider the setting with two product categories – one of high marginal costs and the other of low marginal costs – and an advertising strategy that is conditional on the consumer type. Suppose that the intermediary does not want to engage in de-targeting when choosing its advertising strategy for a consumer who prefers the high marginal cost product category. A consumer who knows that the observed targeting regime depends on her preferred product category will adjust her expected purchase probabilities and de-targeting does not occur even for consumers who prefer the low marginal cost category.[27] However, one may argue that consumers often do not make such an inference, as they would have to understand the intermediary's incentives when to engage in de-targeting. Also, the consumer may not know whether the intermediary has sufficient information to be able to engage in perfect category targeting. With such limited inference, a consumer always believes that she will buy an advertised higher-priced product with positive probability before learning her preferred category. Then, a new de-targeting result arises: for sufficiently low advertising costs, the advertising strategy of the intermediary features de-targeting for consumers who prefer the category with lower marginal costs and perfect category targeting for consumers who prefer the other category. This strategy is optimal because adding higher-priced products to the consideration set reduces the price elasticity of demand, whereas adding lower-priced products does not. With this modified consumer behavior, our theory is thus able to predict category targeting for high-cost product categories, while consumers preferring the low-cost product category will also see ads for products from other product categories.

In reality, de-targeting may be accomplished by the way products are displayed. In particular, when product categories are nested, instead of advertising products from the narrow category of interest, the intermediary may advertise all products from a broader product category. In this sense, de-targeting is identical to the intermediary providing coarser information,

[27]When seeing de-targeting the consumer infers that her preferred category is the low-cost one. As a result, in our analysis in Section 5.1, it can not be an equilibrium that an intermediary advertises products from two categories to one type of consumers and products only from one category to the other type of consumers.

as consumers have to select from a larger number of products.

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# Appendix

## A Relegated Lemma

**Lemma 3.** *Suppose that consumers are loss-averse in the price and the taste dimension. Let* $\Delta p \equiv p' - p_1 \geq 0$, *where* $\mathbf{p} = (p_1, p', ...)$ *and* $p', p_1 \geq 0$. *Then, the cutoffs of the marginal consumers are given by*

$$\hat{x}_1(\Delta p, s) = \min\left\{\frac{\eta(\lambda(3s+1) - (s+1)) + 2s}{2\eta(\lambda - 1)(s+1)} - \frac{\Delta p}{2t(s+1)} - T(\Delta p), 1\right\}, \tag{16}$$

*where*

$$T(\Delta p) \equiv \sqrt{\frac{\Delta p^2}{4(s+1)^2 t^2} - \frac{2\left(\eta\left((\lambda-1) + (3\lambda+1)s + 2s^2\right) + 2s(s+2)\right)\Delta p}{\eta(\lambda-1)(s+1)^2 t} + \frac{4s^2(\eta\lambda+1)^2}{\eta^2(\lambda-1)^2(s+1)^2}}$$

*and* $\hat{x}_j(p_{2j} - p_{2j-1}, s) = 1/2$ *for all* $j > 2$. *Firms' demand functions are given by* $D_{2j-1}(p_{2j} - p_{2j-1}, s) = \hat{x}_j(p_{2j} - p_{2j-1}, s)/J$ *and* $D_{2j}(p_{2j} - p_{2j-1}, s) = (1 - \hat{x}_j(p_{2j} - p_{2j-1}, s))/J$, *for all* $j \in \{1, ..., J\}$.

*Proof of Lemma 3.* $\tilde{u}_1(\hat{x}_1, \{p_i\}_{i\in S_1}) = \tilde{u}_2(\hat{x}_1, \{p_i\}_{i\in S_1})$ is equivalent to the equation in the lemma. This is achieved by a sequence of simple equation manipulations involving the selection of the positive solution of a quadratic equation and taking into account that cutoffs must lie in $[0, 1]$. □

# B Characterization of Reference Point Distribution and Demand

In this appendix, for any vector of feasible prices, we specify the system of utility differences identifying the indifferent consumer and demand in each category. In order to obtain the reference point distribution in the price dimension, suppose that the price vector $\boldsymbol{p} = (p_1, \ldots, p_n)$ is such that the indifferent consumer in each category $k$ is interior, i.e. $\hat{x}_k(\{p_i\}_{i \in S_k}) \in (0, 1)$, where we denote the indifferent consumer in category $k$ by the firm located at the left side of the category. The reference point distribution in the price dimension in category $k$, $F(p, S_k)$, is the probability that the purchase price $p'$ is not larger than $p$. Recall that due to consumers' initial taste uncertainty, the purchase price is not known when consumers form their reference point, even though the prices of firms in $S_k$ are already observed.

Under the uniform distribution of $x$ in each category and because all categories are equally likely to be a consumer's preferred category, we obtain

$$F(p, S_k) = \sum_{i \in \{i \in S_k | p_i \leq p\}} \frac{|y_i - \hat{x}_{\lfloor (i+1)/2 \rfloor}|}{s}, \tag{17}$$

where $y_i \in \{0, 1\}$ denotes the location of firm $i$ and $\lfloor j \rfloor$ the largest integer no larger than $j$. Consider the indirect utility functions of the indifferent consumer in category $k$. Her indirect utility if buying from firm $2k - 1$ can be expressed as

$$\begin{aligned} u_{2k-1}(\hat{x}_k, \{p_i\}_{i \in S_k}) \quad &= (v - t\hat{x}_k - p_{2k-1}) - \lambda\eta \sum_{i \in \{i \in S_k | p_i \leq p_{2k-1}\}} \frac{|y_i - \hat{x}_{\lfloor (i+1)/2 \rfloor}|}{s}(p_{2k-1} - p_i) \\ &+ \eta \sum_{i \in \{i \in S_k | p_i > p_{2k-1}\}} \frac{|y_i - \hat{x}_{\lfloor (i+1)/2 \rfloor}|}{s}(p_i - p_{2k-1}), \end{aligned}$$

where the first term on the RHS describes the indifferent consumer's intrinsic utility from product $2k - 1$. The second term on the RHS shows the loss in the price dimension from not experiencing a lower price than $p_{2k-1}$, whereas the third term shows the gain from not experiencing a higher price than $p_{2k-1}$. If buying from firm $2k$ instead, the indifferent consumer's indirect utility is

$$\begin{aligned} u_{2k}(\hat{x}_k, \{p_i\}_{i \in S_k}) \quad &= (v - t(1 - \hat{x}_k) - p_{2k}) - \lambda\eta \sum_{i \in \{i \in S_k | p_i \leq p_{2k}\}} \frac{|y_i - \hat{x}_{\lfloor (i+1)/2 \rfloor}|}{s}(p_{2k} - p_i) \\ &+ \eta \sum_{i \in \{i \in S_k | p_i > p_{2k}\}} \frac{|y_i - \hat{x}_{\lfloor (i+1)/2 \rfloor}|}{s}(p_i - p_{2k}). \end{aligned}$$

By setting $u_{2k-1} - u_{2k} = 0$ for all $k$ and solving for $\{\hat{x}_k\}_{k=1}^J$, we determine the locations of indifferent loss-averse consumers (consumers' personal equilibria) for any given $\boldsymbol{p}$ (provided that a solution exists). The corresponding demand of a firm $i$ equals $|y_i - \hat{x}_{\lfloor (i+1)/2 \rfloor}|/J$ for all $i \in \{1, ..., 2J\}$.

# C The Symmetric Equilibrium Price Correspondence

In this appendix, we derive the minimal price equilibrium and provide a full characterization of the equilibrium set. Without loss of generality, consider product 1 in product category 1. We use the notation, $\mathbf{p} = (p_1, p', ..., p')$ to consider an upward deviation by firm 1 from the symmetric price setting, i.e. $p_1 > p'$. The indifferent consumer with preferred category $k = 1$ obtains the following utility when buying product 1,

$$u_1(\hat{x}_1^-, \{p_i\}_{i \in S_1}) = v - t\hat{x}_1^- - p_1 - \eta\lambda(1 - \text{Prob}[p = p_1; \{p_i\}_{i \in S_1}])(p_1 - p'). \tag{18}$$

For the competing product, the indifferent consumer with preferred category $k = 1$ obtains utility,

$$u_2(\hat{x}_1^-, \{p_i\}_{i \in S_1}) = v - t(1 - \hat{x}_1^-) - p' + \eta\text{Prob}[p = p_1; \{p_i\}_{i \in S_1}](p_1 - p'). \tag{19}$$

The indifferent consumer in category $k = 1$, $(\hat{x}_1^-, 1)$, is characterized by $\Delta u(\hat{x}_1^-, \{p_i\}_{i \in S_1}) \equiv u_1(\hat{x}_1^-, \{p_i\}_{i \in S_1})) - u_2(\hat{x}_1^-, \{p_i\}_{i \in S_1}) = 0$. It holds that

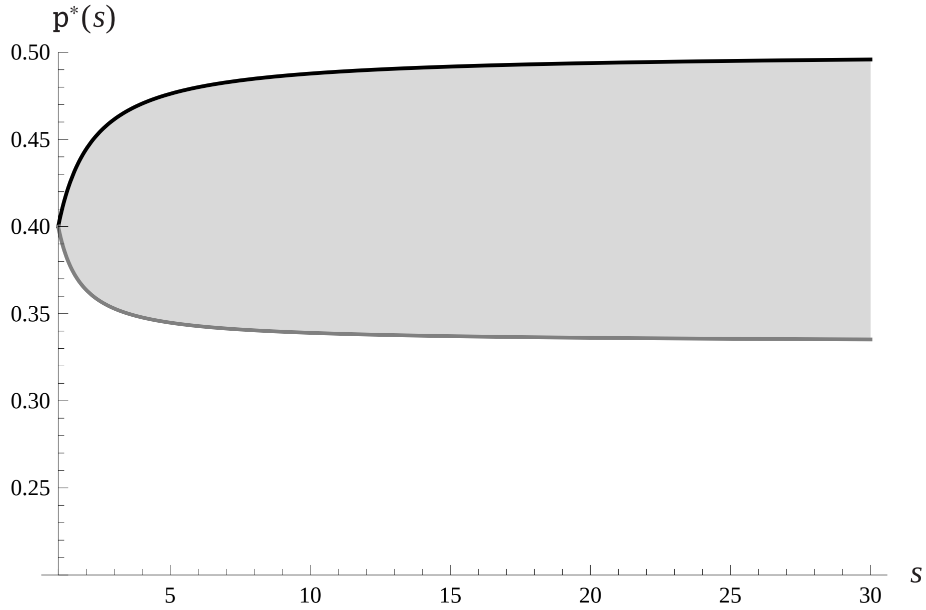
$$\Delta u(\hat{x}_1^-, \{p_i\}_{i \in S_1})) = \Big( - 1 - \eta\lambda + \eta(\lambda - 1)\text{Prob}[p = p_1; \{p_i\}_{i \in S_1}]\Big)(p_1 - p') - t(2\hat{x}_1^- - 1). \tag{20}$$

Analogously to the analysis in the main text, we use that the probability a consumer observing $S_1$ assigns to buying from firm 1, $\text{Prob}[p = p_1; \{p_i\}_{i \in S_1}]$, equals $(\hat{x}_1^-/s$ for given prices $\mathbf{p} = (p_1, p', ...)$ and number $s \in \{1, ..., J\}$ of product categories disclosed to each consumer in category $k = 1$. The following lemma describes the location of the indifferent consumer $\hat{x}_1^-$ and firms' demand.

**Lemma 4.** *Suppose that* $\Delta p \equiv p' - p_1 \leq 0$, *where* $\mathbf{p} = (p_1, p', ...)$ *and* $p', p_1 \geq 0$. *Then, the marginal consumers are located at*

$$\hat{x}_1^-(\Delta p, s) = \max\{\frac{s(t + (1 + \eta\lambda)\Delta p)}{2st - \eta(\lambda - 1)\Delta p}, 0\}$$

*and* $\hat{x}_k(0, s) = 1/2$ *for all* $k > 2$. *A firm i's demand is given by* $D_i(\Delta p, s) = \hat{x}_{\lfloor (i+1)/2 \rfloor}(\Delta p, s)/J$ *for all* $\Delta p \geq 0$ *and* $i \in \{1, ..., 2J\}$.




Equilibrium price correspondence $\mathrm{p}^*(s)$ as a function of number observed categories $s \leq J$ for parameter values of $t = 1$, $\eta = 1$, $\lambda = 2$.

Figure 2: Equilibrium price correspondence

*Proof of Lemma 4.* The location of the marginal consumer in category $k = 1$ can be directly derived by transforming $u_1(\hat{x}_1^-, (p_1, p', ...)) - u_2(\hat{x}_1^-, (p_1, p', ...)) = 0$, taking into account that cutoffs must lie in $[0, 1]$. All other locations follow trivially. □

To characterize the symmetric equilibrium, it is sufficient to show that a price deviation by a single firm given symmetric prices of all other firms. The minimal equilibrium is characterized when solving the first-order condition of a firm that slightly increases its price.

**Proposition 6.** *The minimal symmetric equilibrium markup is given by*

$$p_i^{*-}(s) - c = \frac{2t}{2(1 + \eta\lambda) - \frac{\eta(\lambda-1)}{s}}, \quad i \in \{1, ..., 2J\}. \tag{21}$$

*It is decreasing in the number* $s \in \{1, ..., J\}$ *of product categories disclosed to each consumer.*

The proof of this proposition is analogous to that of Proposition 1 using the demand specified in Lemma 4 instead of Lemma 1. The symmetric equilibrium price correspondence is illustrated in Figure 2; the upper bound of the gray shaded area shows the maximal equilibrium markup (solid black line). The lower bound (solid gray line) shows the minimal equilibrium markup $p_i^{*-}(s) - c$, which is decreasing in $s$.

# D Monopoly Profit with Loss-Averse Consumers

We consider parameter constellations such that the market (in each category) is only partially covered in monopoly, while it is fully covered under symmetric duopoly; this is a necessary condition for industry profits to be larger with duopoly firms than monopoly firms. With consumers who do not have a gain-loss utility (i.e., for $\eta = 0$) and parameters such that the market is partially covered in monopoly, the monopoly profit of the industry equals

$$\pi^m = (p^m - c)D^m = \frac{(v-c)^2}{4t}.$$

Partial market coverage requires that the utility of the consumer located at the opposite end of the Hotelling line than the monopolistic firm is strictly negative. This is equivalent to $v - c \leq 2t$. With consumers who do not have a gain-loss utility the duopoly profit of the industry equals $2\pi^d = t$ and therefore the condition that $2\pi^d \geq \pi^m$ (see Section 3) is also identical to $v - c \leq 2t$. Furthermore, the condition that under duopoly the market is fully covered, i.e. the consumer located at $x_k = 1/2$ has non-negative utility for any category $k$, is equivalent to $v - c \geq 3t/2$. Therefore, when consumers who do not have a gain-loss utility it suffices to restrict to parameter values of $v - c \in [3t/2, 2t]$ in order to obtain an outcome where the intermediary's advertising strategy is such that the price of both firms in a category instead of only one of the two are announced.

In partially covered monopolistic markets, *expectation-based loss-averse consumers* perceive an additional loss from buying. The reason is that they expect not to buy with a positive probability before inspection. Under the monopoly regime, the intermediary's advertising strategy features only one price per category. Without loss of generality, assume that this price equals $p_{2k-1}$ in any category $k$. Suppose $\mathbf{p} = (p_1, p', ..., p')$, where $\mathbf{p}$ is a vector of $J$ prices and $p_1 < p'$. If $S_1$ contains at least two categories (i.e., four products with two different prices), then the marginal consumer with preferred category $k = 1$ obtains the following utility when buying product 1,

$$\begin{aligned} u_1(\hat{x}_1, \{p_i\}_{i\in S_1}) =& v - t\hat{x}_1 - p_1 - \eta\lambda\Big(1 - \text{Prob}[p = p_1; S_1] - \text{Prob}[p = p'; S_1]\Big)p_1 \\ &+ \eta\text{Prob}[p = p'; S_1](p' - p_1), \end{aligned} \tag{22}$$

where $(1 - \text{Prob}[p = p_1; S_1] - \text{Prob}[p = p'; S_1])$ denotes the probability of not buying. In case of not buying, the marginal consumer with preferred category $k = 1$ obtains the following utility

$$u_0(\hat{x}_1, \{p_i\}_{i\in S_1}) = 0 + \eta \text{Prob}[p = p_1; S_1]p_1 + \eta \text{Prob}[p = p'; S_1]p'. \tag{23}$$

To solve for the personal equilibrium of consumers, $\text{Prob}[p = p'; S_1]$ has to be determined, where $S_1$ has the cardinality $s$ because only one price per category is advertised. Analogous to Section 4, we receive that $\text{Prob}[p = p_1; S_1] = \hat{x}_1/s$ and $\text{Prob}[p = p'; S_1] = (s-1)\hat{x}_{j\neq 1;S_1}/s$. Note that these expressions also incorporate the case when $s = 1$ and the gain-loss utility terms including $p'$ drop out. In order to solve for $\hat{x}_{j\neq 1;S_1}$ if $s > 1$, consider the utility of the marginal consumer with preferred category $k \neq 1$ who observed the prices in $S_1$,

$$\begin{aligned} u_{j\neq 1;S_1}(\hat{x}_{j\neq 1;S_1}, \{p_i\}_{i\in S_1}) =& v - t\hat{x}_{j\neq 1;S_1} - p' - \eta\lambda\Big(1 - \text{Prob}[p = p_1; S_1] - \text{Prob}[p = p'; S_1]\Big)p' \\ & - \eta\lambda \text{Prob}[p = p_1; S_1](p' - p_1). \end{aligned} \tag{24}$$

Now the system of equations $u_1 - u_0 = 0$ and $u_{j\neq 1;S_1} - u_0 = 0$ can be solved for $\hat{x}_1$ and $\hat{x}_{j\neq 1;S_1}$.

The following lemma characterizes the location of the marginal consumers $\hat{x}_1$ and $\hat{x}_{j\neq 1;S_1}$ as well as firms' demand.

**Lemma 5.** *Suppose that the intermediary decides to advertise only one price per category and that $p' \geq p_1 \geq 0$, where $\mathbf{p} = (p_1, p', ..., p')$. Assume that $s \geq 1$. Then, the marginal consumer(s) in categorie(s) in $S_1$ are located at*

$$\hat{x}_1(p_1, p', s) = \min\{\frac{s(v((\lambda-1)\eta(s-1)(p-p_1) - st) + p_1 st(\lambda\eta+1))}{-(\lambda-1)^2\eta^2 p_1(s-1)(p-p_1) + (\lambda-1)\eta st(p(s-1)+p_1) - s^2t^2}, 1\}$$

*and*

$$\hat{x}_{j\neq 1;S_1}(p_1, p', s) = \min\{\frac{s((\lambda\eta+1)((1-\lambda)\eta p_1(p-p_1) + pst) - stv)}{-(\lambda-1)^2\eta^2 p_1(s-1)(p-p_1) + (\lambda-1)\eta st(p(s-1)+p_1) - s^2t^2}, 1\}.$$

*A firm $2j-1$'s demand is given by $D^m_{2j-1}(p_1, p', s) = \hat{x}_j(p_1, p', s)/J$ for all $p' \geq p_1 \geq 0$ and $2j-1 \in S_1$.*

*Proof of Lemma 5.* The proof is analogous to that of Lemma 1. □

Solving the first-order condition of the representative monopolist in category 1 imposing symmetry across categories leads to the following proposition.

**Proposition 7.** *The monopoly equilibrium markup is given by*

$$p^{m*}_{2j-1}(s) - c = \frac{s(2t(\lambda\eta+1) - (\lambda-1)\eta v) - R(s) + (\lambda-1)\eta v}{2(\lambda-1)\eta(\lambda\eta+1)}, \quad j \in \{1, ..., J\}, \tag{25}$$

*where*

$$R(s) \equiv \sqrt{((\lambda-1)\eta(s-1)v - 2st(\lambda\eta+1))^2 - 4(\lambda-1)\eta stv(\lambda\eta+1)}. \tag{26}$$

*It is increasing in the number $s \in \{1, ..., J\}$ of prices disclosed to each consumer.*

*Proof of Proposition 7.* The proof is straight forward and therefore omitted. □

The industry profit under monopoly, $\pi^{m*}(s) = J \cdot \pi^{m*}_{2j-1}(s)$ is given by

$$(p^{m*}_{2j-1}(s) - c) \cdot \hat{x}_1(p^{m*}_{2j-1}(s), p^{m*}_{2j-1}(s), s) \tag{27}$$

It can be easily shown that $\pi^{m*}(s)$ is decreasing in $s$. Therefore, the relevant expression for the comparison between monopoly and duopoly industry profits under loss aversion is given by

$$\pi^{m*}(1) = \frac{v^2}{R(1) + 2t(\lambda\eta+1) - (\lambda-1)\eta v}, \tag{28}$$

where, for brevity, marginal costs are neglected, i.e. $c = 0$. The corresponding duopoly industry profit is given by $2\pi^{d*}(s^*) = p^*_{2j-1}(s^*) - (s^*-1)2a$ with $p^*_{2j-1}(s)$ as in (4) and $(s^*-1)2a$ as an adjustment for de-targeting advertising costs beyond $s = 1$.[28] Note that, for $\lambda = 1$ and $\eta = 0$, both industry profits nest the case without gain-loss utility discussed above. While $p^*_{2j-1}(s^*) - (s^*-1)2a$ is strictly decreasing in $\lambda$ and $\eta$, $\pi^{m*}(1)$ is either strictly decreasing and then strictly increasing in $\lambda$ and $\eta$ for $v$ close to $3t/2$ or always strictly increasing in $\lambda$ and $\eta$ for larger $v \in [3t/2, 2t]$. Hence, $2\pi^{d*}(s^*) > \pi^{m*}(1)$ is generically satisfied for $v$, $\eta$, and $\lambda$ sufficiently low in their feasible range. For example, treating $s$ as a continuous variable, at $\lambda = 2$, $\eta = 1$, $t = 1$, and advertising costs $a = 0.01$, it holds that $v \in [1.5, 1.8333]$ instead of $v \in [1.5, 2]$ when consumers do not experience gain-loss utility ($\eta = 0$).

# E Equilibrium Existence

In this appendix, we investigate equilibrium existence. We show that a symmetric equilibrium always exists.

It suffices to consider only price deviations by at most one firm from a candidate equilibrium price and a symmetric number $s \geq 1$ of categories being disclosed to all consumers. Then, for any category $k \in \{1, ..., J\}$, the demand of firm $2k-1$ and firm $2k$ are determined by Lemma 1. We define the price difference between the two firms in a category to be non-negative if and

[28] Advertising costs for $s = 1$ occur under both, monopoly and duopoly and can therefore be collectively ignored.

only if firm $2k-1$ sets a weakly lower price than firm $2k$, i.e. $\Delta p = p_{2k} - p_{2k-1} \geq 0$. This leads to the following demand functions

$$D_{2k-1}(\Delta p, s) = \begin{cases} q(\Delta p, s)/J, & \text{if } \Delta p \in [0, \Delta\overline{p}(s)]; \\ (1 - q(-\Delta p, s))/J, & \text{if } \Delta p \in [-\Delta\overline{p}(s), 0). \end{cases} \quad \text{and } D_{2k}(\Delta p, s) = 1 - D_{2k-1}(\Delta p, s),$$

where, by Lemma 1,

$$q(\Delta p, s) \equiv \frac{s(t + (1+\eta)\Delta p)}{2st - \eta(\lambda - 1)\Delta p}$$

and $\Delta\overline{p}(s)$ is determined by $q(\Delta\overline{p}(s), s) = 1$ which leads to

$$\Delta\overline{p}(s) \equiv \frac{st}{\eta(\lambda + s - 1) + s}.$$

It is easy to verify that $q(\Delta p, s)$ is strictly increasing and strictly convex in $\Delta p \in [0, \Delta\overline{p}(s)]$. Hence, $D_{2k-1}(\Delta p, s)$ is strictly decreasing and strictly convex in $p_{2k-1} \in [p_{2k} - \Delta\overline{p}(s), 0]$. Because of the convexity of the demand function, we have to check whether the profit function is globally quasi-concave in order to proof existence. The second derivative of $q(\Delta p, s)$ in $\Delta p$ equals

$$q''(\Delta p, s) = \frac{2(\lambda - 1)\eta st(\eta(\lambda - 1 + 2s) + 2s)}{(2st - \eta(\lambda - 1)\Delta p)^3} > 0 \text{ for } \Delta p \in [0, \Delta\overline{p}(s)]$$

and is strictly decreasing in $s$ for $\Delta p \in [0, \Delta\overline{p}(s)]$, i.e.

$$\frac{\partial q''(\Delta p, s)}{\partial s} = -\frac{2(\lambda - 1)\eta t(\Delta p(\lambda - 1)\eta(\eta(\lambda - 1 + 4s) + 4s) + 4st(\eta(\lambda - 1 + s) + s))}{(\Delta p(\lambda - 1)\eta - 2st)^4} < 0.$$

Moreover, in the limit, convexity of $q(\Delta p, s)$ vanishes, i.e. $\lim_{s\to\infty} q''(\Delta p, s) = 0$. Consequently, in the following, it suffices to focus on the most critical case for equilibrium existence, i.e. on $s = 1$.

For any firm $i = 2k - 1$ with $k \in \{1, ..., J\}$, the profit function is given by $\pi_i = (p_i - c)q(\Delta p, s)/J$, and analogously for any firm $j = 2k$, replacing $q(\Delta p, s)$ by $(1 - q(\Delta p, s))$. The second-order condition equals

$$\frac{\partial^2 \pi_i}{\partial p_i^2} = -2q'/J + (p_i - c)q''/J < 0, \tag{29}$$

where $q = q(\Delta p, s)$, $q' = \partial q(\Delta p, s)/\partial\Delta p$, and $q'' = \partial^2 q(\Delta p, s)/\partial\Delta p^2$. Using that $(p_i - c) = q/q'$ by first-order condition of firm $i$, its second-order condition can be expressed as

$$-2(q')^2 + qq'' < 0. \tag{30}$$

Using the definition of $q$, this is equivalent to

$$\frac{2(\eta+1)s^2t(\eta(\lambda+2s-1)+2s)}{((\lambda-1)\eta(\Delta p)-2st)^3}<0.$$

It is easy to show that the LHS of the second-order condition is increasing in $\Delta p$. Hence, the second-order condition is satisfied for all $\Delta p \in [0, \Delta\overline{p}(s)]$ if it is satisfied at $\Delta p = \Delta\overline{p}(s)$. At $\Delta p = \Delta\overline{p}(s)$, it equals

$$-\frac{2(\eta+1)(\eta(\lambda+s-1)+s)^3}{st^2(\eta(\lambda+2s-1)+2s)^2},$$

which is clearly negative for all $s \geq 1$. This yields existence.

The next proposition summarizes.

**Proposition 8.** *A symmetric equilibrium with prices $p_i^*(s)$ determined in equation (4) for all $i \in \{1, ..., 2J\}$ exists for all $s \geq 1$.*

The proof is given in the text above.[29]

[29]If also loss aversion in the taste dimension is considered, global quasi-concavity of the profit functions could be violated for $\eta$ and $\lambda$ sufficiently large. See Karle and Peitz (2014) for a characterization of the critical upper bound on the degree of loss aversion such that existence is maintained in this case.