Why Brand Manufacturers Should Take Loss Leading Seriously

Roman Inderst* Martin Obradovits†

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Abstract

Manufacturers frequently resist heavy discounting of their products by retailers, especially when they are used as so-called loss leaders. Since low prices should increase demand and manufacturers could simply refuse to fund deep price promotions, such resistance is puzzling at first sight. We explain this phenomenon in a model in which price promotions cause shoppers to potentially reassess the relative importance of quality and price, as they evaluate these attributes relative to a market-wide reference point. With deep discounting, quality can become relatively less important, eroding brand value and the bargaining position of brand manufacturers, hurting their profits and potentially even leading to a delisting of their products. Linking price promotions to increased one-stop shopping and more intense retail competition, our theory also contributes to the explanation of the rise of store brands.

*Johann Wolfgang Goethe University Frankfurt. E-mail: inderst@finance.uni-frankfurt.de.
†University of Innsbruck. E-mail: martin.obradovits@uibk.ac.at.

1 Introduction

"*We take loss leading of our brands very seriously.*" This exemplary statement was delivered by a spokesperson of Foster's, who justified the company's blitz action to withdraw key stock from two Australian supermarket chains after learning of their promotion to sell Foster's beer brands below cost.[1] It echoes brand manufacturers' general concerns about losing margins and brand value when retailers heavily discount their products.[2,3] This seems to be the case especially when retailers engage in price wars and promote branded products to such an extent that they turn into loss leaders. As discounted prices should however boost demand for the respective manufacturers' products and as there is prima facie no reason why manufacturers would need to fund such deep price promotions, manufacturers' resistance seems puzzling.

In fact, when consumers exhibit standard preferences, we show that brand manufacturers' fears are unfounded in our model. As retailers' lower prices expand demand, manufacturers would tend to benefit when their product is chosen as loss leader, rather than being adversely affected by the retailer's margin loss. In contrast, our model supports manufacturers' resistance against deep discounts when consumers, faced with frequent price promotions, reassess their relative preferences for price and quality and make such reassessment dependent on a market-wide reference point. Below we provide various foundations for our formal modelling of such "relative thinking". As we note there as well, the

[1] The Sydney Morning Herald, March 23, 2011, "Beer war as Foster's takes on chains to stop sale of $28 cases", `https://www.smh.com.au/business/beer-war-as-fosters-takes-on-chains-to-stop-sale-of-28-cases-20110322-1c5cd.html`, accessed September 7, 2020.

[2] Staying with the country of the initial quote, Australia, the following article provides an example where leading brand manufacturers of bread and milk reported trading losses and the need to cut cost, naming discounted prices at competing retailers as the primary reasons (The Sydney Morning Herald, November 22, 2011, "Heinz hits out at home brands", `https://www.smh.com.au/business/heinz-hits-out-at-home-brands-20111121-1nr1l.html`, accessed September 7, 2020). In the same article, as the title suggests, Heinz' CFO blamed "relentless promotional pressure" at the two national discounters, Coles and Woolworths, as the main reason for bad financial performance.

[3] Turning to another country, in a well-known case in 2014, Lidl, one of the largest German discounters, stopped selling Coca-Cola, with both sides citing different views about the product's store price as reason. This was preceded by heavy discounting of Coca-Cola at the discounter (Welt, January 29, 2014, "Coca-Cola kämpft sich zurück in das Lidl-Regal" ["Coca-Cola fights its way back to the Lidl shelf"], `https://www.welt.de/wirtschaft/article124337516/Coca-Cola-kaempft-sich-zurueck-in-das-Lidl-Regal.html`, accessed September 7, 2020). Given Germany's notoriously competitive food retailing industry, manufacturers frequently express concerns about the impact of price wars on their brand value and profits (e.g., Welt, January 29, 2017, "Unilever kritisiert 'Brandrodung' im Supermarkt" ["Unilever criticizes 'fire clearing' in the supermarket"], `https://www.welt.de/wirtschaft/article161630067/Unilever-kritisiert-Brandrodung-im-Supermarkt.html`, accessed September 7, 2020).

notion that relative preferences over various attributes of an offer depend on some market-wide reference point has a long-standing tradition in Marketing, Psychology and more recently Behavioral Economics.[4] When consumers exhibit such preferences, retailers' deep discounting undermines brand manufacturers' bargaining power vis-à-vis retailers, leading to lower profits and possibly even to a delisting of their products, such as in favour of store brands.

To our knowledge, this paper is the first to analyze the impact of such heavy discounting by retailers on the profits of manufacturers whose brands are discounted in this way, in contrast to profits of manufacturers in non-promoted categories. Importantly, the mechanism by which such deep discounting negatively affects manufacturer profit is such that the manufacturer could not escape these negative implications by adopting retail-price-maintenance (RPM) strategies (provided that they are not anyhow prohibited by antitrust laws[5]). This is so as in our model a retailer's price-cutting of a particular product does not by itself undermine a consumer's perception of the product's quality or brand value.[6] Instead, the mechanism depends entirely on the comparison with other offers in the market, whose lower price (and thereby, the resulting lower reference price) affects the relative importance of quality and price. To defend the value of their brand and thereby their bargaining position vis-à-vis retailers, brand manufacturers in a given category would have to act in concert to prevent that their products are used as loss leaders.[7] Such horizontal agreements would clearly fall foul of antitrust laws. Hence, when manufacturers are rightly concerned that retailers' loss leading reduces their bargaining position and destroys brand value, they need to rely on the support of regulation and antitrust laws. In the US federal law does not restrict below-cost selling, but several states have enacted respective laws.[8] Other countries have stricter rules or specifically forbid below-cost selling in food

[4]Possibly the most widely known evidence of such preferences relates to an experiment conducted by Tversky and Kahnemann (1981). They document that 68% of subjects were willing to drive 20 minutes to save $5 on the purchase of a calculator when the price was $15, but less than half of this fraction (29%) were willing to do so in order to save again $5 when the price was instead $125.

[5]RPM is severely restricted in the European Union, where some countries even treat it similarly to anticompetitive practices prohibited *per se*. Since the 2007 Leegin-decision of the US Supreme court, which clearly ruled against a *per-se* prohibition of RPM, in the US matters are less clear-cut − also as some states, like California under the Cartwright-Act, still seem to practice such a prohibition.

[6]Indeed, such a mechanism would seem more reasonable with luxury products, where a high price may itself be a vital trait of the product (e.g., as it communicates to others the owner's income and wealth or as it ensures that there is only a small, selective group of such owners).

[7]As unilateral strategies have no effect, this also applies to the threat of terminating dealers when they do not adhere to a certain price. At least in the US, under the so-called "Colgate exception", such a practice would typically not be regarded as unlawful.

[8]In California, for instance, Section 17044 in the Business and Professions Code states that "[i]t is

retailing. Even when there is no outright ban or when this is not rigorously enforced, manufacturers may be able to constrain retailers by raising the awareness of policymakers or the public.[9]

In our model, the depth of discounts offered in the promoted category is tightly linked to the extent of consumer one-stop shopping, that is, the size of consumers' baskets at individual shopping trips. For the retailer, this warrants deep discounts on selected items to compete for consumers' overall basket. Our mechanism may thus shed new light on some general trends that shaped retailing over the last decades, particularly in the food sector. In our model, retailers ultimately replace branded high-quality products with potentially lower-quality store brands (private labels). Even when this is (still) not the case, one-stop shopping shifts bargaining power towards retailers and away from brand manufacturers, as brand value becomes less of an advantage, at least in the promoted category. Precisely, when the price level in the promoted category decreases due to an increase in one-stop shopping, low price, rather than superior brand quality, becomes relatively more important in the eyes of consumers. This may have contributed to the widely observed growth of private labels.[10] Also, again following the main thrust of our model and argument, an increase in competition for promoted products reduces the bargaining power of brand manufacturers, which can thus no longer bank on their superior quality or investment in brand value. In our concluding remarks, we argue how this should have far-reaching implications for brand manufacturers' product positioning and investment strategies.

Another insight of our model is that brand manufacturers, particularly those of promotion-intense, loss-leading products, should be aware of increasing retail competition. This could be triggered by the entry of hard discounters or, potentially, also by the rise of alternative shopping formats, such as online retailing – even more so if this forces retailers to compete more aggressively on few, particularly visible products.

We set up an analytically tractable model that combines retail price promotions, manufacturer-retailer negotiations and manufacturer vertical differentiation – solved both

unlawful for any person engaged in business within this State to sell or use any article or product as a 'loss leader' as defined in Section 17030 of this chapter."

[9]The latter applies to Germany since the 2017 reform of the antitrust law. Other European countries that have restrictions on below-cost pricing are Belgium, France and Ireland.

[10]There is by now a large literature documenting and analyzing the spread of store brands. For an early survey see, e.g., Bergès-Sennou et al. (2004). Various rationales have been proposed for why retailers introduce store brands, e.g., so as to exert downwards pricing pressure on national brands (Mills (1995); cf. Chitagunta et al. (2002) for an empirical analysis). In our model, instead, retailers are only reactive to external forces (e.g., the increase in one-stop shopping). As, in line with the literature, shoppers in our model exhibit the same preferences, at present our model can not be immediately extended to the case where in a given category store brands and national brands are simultaneously offered by a given retailer.

with standard consumer preferences and preferences exhibiting "relative thinking". This framework, which remains tractable even under such modified preferences, may prove useful also for other research questions. Precisely, our model combines the following four key elements. First, to capture frequent price promotions, we employ a "model of sales", as in Varian (1980) or Narasimhan (1988). Second, due to limitations either in consumer attention or advertising space, such promotions take place only in one category, following Lal and Matutes (1994).[11] We can compare implications for this loss-leading category and other categories. Third, as we are interested in the distribution of profits between retailers and manufacturers, we model the manufacturer-retailer channel via vertical contracting. In models of sales, as the present one, the channel perspective is instead typically ignored. Fourth, next to our benchmark case with standard preferences, we employ a model of consumer reference-dependent (relative) preferences. Importantly, these preferences are effective only for consumers who actually compare offers across retailers, so-called shoppers, such that an increase in consumers' propensity to shop also increases the prevalence of relative thinking in the market. We introduce our specific form of consumer preferences and relate this to the large literature in Marketing and Behavioral Economics in a separate section below.

With this in mind, the remainder of this paper is organized as follows. Section 2 sets out the model. Section 3 solves the baseline case where consumers follow a standard choice criterion, thereby setting up the respective puzzles. Section 4 introduces and discusses our consumer choice criterion under relative preferences. Section 5 presents the main analysis under such preferences. Section 6 concludes with a collection of implications. All proofs are relegated to the Appendix.

2 The Market

In our model, retailers compete for final consumers, who are one-stop shoppers and thus purchase all products at a single outlet. Manufacturers compete for shelf space in different product categories. We are interested primarily in retailers' and consumers' product selection as well as in manufacturers' profits.

Suppose thus that products are sold through N retailers. We simplify the exposition of results by setting $N = 2$, though we note that all insights readily extend to competition

[11] In our already rich model, we however do not endogenize which of the considered product categories is used by retailers for promotions. That the extent of loss leading is indeed related to the possibility of cross-selling has also been documented empirically, e.g., in Li et al. (2013).

among $N > 2$ retailers.[12] Given the already rich structure of our model, we next impose symmetry along various dimensions. We suppose that each retailer stocks $I \geq 1$ products, such that I is a measure of the extent of one-stop shopping.[13] It is convenient to also denote the respective sets of retailers and products by N and I. The price of product i at retailer n is p_n^i, and we suppose that the respective quality can be described by a real-valued variable q_n^i.

Manufacturers. Each product i can be supplied at different qualities. We again impose symmetry, which, as we will see, serves primarily the purpose of simplifying the exposition.[14] We thus suppose that each product can be supplied in two qualities $q_H > q_L$ with respective constant marginal costs of production $c_H > c_L$. As will become clear, the model could easily be extended to allow for different quality levels $c_{L,i}$ and $c_{H,i}$ in each category, albeit this would make expressions less transparent. Denote $\Delta_q = q_H - q_L$ and $\Delta_c = c_H - c_L$. We abstract from retailers' own (handling) costs, which however can be included without affecting results.

Motivated by our introductory remarks, we focus on the profits of high-quality (brand) manufacturers and stipulate that $\Delta_q > \Delta_c$, such that retailers may indeed find it advantageous to stock high-quality products. Note that as all customers have the same preferences, which we specify below, there are no benefits from stocking both the high- and the low-quality product.[15] In each product category, we suppose that the low-quality variant can be supplied by at least two otherwise undifferentiated suppliers, or that it represents a private label. The obvious implication of this specification is that the low-quality variant can always be procured at cost c_L. We next discuss the provision of the high-quality product.

We know from the large literature on vertical contracting and channel management that the equilibrium characterization depends crucially on whether retailer competition can be affected through the strategic choice of wholesale contracts.[16] In this paper, we wish to

[12] Strictly speaking, this is the case as long as we still impose symmetry. This holds as even when there are multiple (mixed-strategy) pricing equilibria in the subsequently specified model of promotions when $N > 2$, it is well-known that they all result in the same level of profits.

[13] We do not model consumers' choice for one-stop shopping. An increase in I may have exogenous reasons, in particular when considered over a longer time horizon, such as caused by a change in mobility.

[14] Precisely, we will subsequently see that, for the purpose of our analysis, we can summarize the provision of all products $i > 1$ into a single variable (capturing retailers' equilibrium profit margins from these products).

[15] An extension with horizontal differentiation must be left to future research. With relative thinking, as specified below, it would be necessary to take a stance whether this applies only when shoppers compare promotions across stores, i.e., before selecting a store, or also when they compare various offers on the shelf.

[16] In fact, the most obvious case is that of a monopolistic (brand) manufacturer who could commit to

abstract from such issues of optimal channel management and thus choose a specification that, independently from the choice of a particular supplier, results in marginal wholesale prices equal to marginal costs. One such way is to stipulate that even when a manufacturer supplies both retailers, he negotiates separately (through independently acting agents) with both retailers. As the intricacies of bilateral negotiations are also not the topic of our model, we stipulate that in each such bilateral relationship the manufacturer's agent makes a take-it-or-leave-it offer.[17] As long as the negotiated contract is sufficiently flexible, as is the case with so-called "two-part tariff contracts", it is well-known that in this case the marginal wholesale price equals the supplier's marginal cost,[18] which we also establish formally below.[19] An alternative way to obtain such a result is when for each retailer there is some "dedicated" manufacturer, such that the problem becomes one of competing vertical chains. We finally denote the "two-part tariff contract" offered to retailer n in category i by a fixed fee T_n^i together with a constant (per-unit) wholesale price w_n^i.

Consumers. We now turn to consumers. Suppose first that $I = 1$. Here, our model fully follows Varian (1980). We stipulate that a fraction $(1-\lambda)/2$ of consumers can only shop at their (local) retailer n (for each $n \in \{1,2\}$), such that a total fraction $1-\lambda$ of consumers does not compare offers. In contrast, the remaining fraction λ of consumers, called "shoppers", is free to choose any retailer, so that λ also captures the intensity of competition.

Suppose next that there is one-stop shopping as $I > 1$. We now stipulate that only the offer of product $i = 1$ is observed before a consumer enters the respective shop. Shoppers thus observe offers (q_n^1, p_n^1) across retailers, while non-shoppers observe the respective offer only for their (local) retailer. No consumer observes offers for products $i > 1$ before they enter a shop, though they hold (rational) expectations $(\widehat{q}_n^i, \widehat{p}_n^i)$. Once in a shop, a consumer then decides which subset of products $I' \subseteq I$ to buy, thereby realizing the respective utility

observable offers to all retailers and thereby dampen retail competition by a high marginal wholesale price (together with a low inframarginal price or likewise a negative fixed transfer). For a recent discussion of various models with such observable contracts see Inderst and Shaffer (2019).

[17]Models where a supplier or retailer negotiates through independent agents are widely used in the literature, albeit often in combination with the application of the Nash-bargaining solution to determine the distribution of surplus in each bilateral relationship. Admittedly, such an approach, where a player can not orchestrate a simultaneous deviation across all his agents, has come under scrutiny, albeit some recent contributions have provided a foundation for this through an appropriate extension of the respective game form (e.g., Inderst and Montez 2020).

[18]Cf. Inderst and Wey (2010).

[19]Without independent agents, the extreme opportunism outcome hinges on non-observability, retailers' out-of-equilibrium beliefs and demand elasticity.

$\sum_{i\in I'}(q_n^i - p_n^i)$. We normalize consumers' reservation value to zero and assume that they demand at most one unit in each product category. We leave to the next section the choice criterion for shoppers' selection among retailers.

As we discussed in the Introduction, product $i = 1$ falls into the prominent category that will be advertised by retailers. For our purpose, it is inconsequential whether consumers' limited ex-ante knowledge of offers for products $i > 1$ is due to limited attention or memory or whether it follows from limits to advertising space. Though products in category $i = 1$ will be offered below cost only when I is sufficiently large, for convenience we always refer to them as loss leaders.

Negotiations and Competition. We now summarize more formally the interaction of retailer-manufacturer negotiations and retailer competition. For this we set up three different time periods, $t = 1$ to $t = 3$. In $t = 1$, at each retailer $n = 1, 2$ and for each product category i, the corresponding brand manufacturer with high quality q_H and costs c_H and at least two non-brand manufacturers with quality q_L and costs c_L compete by simultaneously offering contracts to the respective retailer. Then, in $t = 2$, retailers simultaneously choose for each category i which product to stock, i.e., which contract to accept, and at which prices p_n^i to offer these to consumers. Finally, in $t = 3$ consumers choose which retailer to frequent and which bundle to purchase. Precisely, recall that of the fraction $1 - \lambda$ of non-shopping (loyal) consumers, half frequents retailer 1 and half frequents retailer 2. The fraction λ of shopping consumers decides which retailer to visit, depending on, first, observed prices and quantities (q_n^1, p_n^1) for product $i = 1$ and, second, when there is one-stop shopping as $I > 1$, on the anticipated choices $(\widehat{q}_n^i, \widehat{p}_n^i)$ for products $i > 1$. Once in a shop, a consumer purchases a product i if and only if $q_n^i - p_n^i \geq 0$.

3 Benchmark Analysis

In our benchmark analysis we suppose that consumes have standard preferences throughout, so that shoppers choose the retailer for which

$$(q_n^1 - p_n^1) + \sum_{i>1}(\widehat{q}_n^i - \widehat{p}_n^i) \tag{1}$$

is highest. Most of the subsequent analysis for the baseline model follows well-established results, which is why we can be short, though all remaining gaps are filled in the proofs in the Appendix.

So as to avoid double-marginalization, in equilibrium products are provided to the retailer at a marginal wholesale price that is equal to marginal cost. Depending on the chosen quality q_n^i, the retailer's marginal cost of offering product i is thus either $w_n^i = c_L$ or $w_n^i = c_H$. Given manufacturer competition for the provision of the low-quality product, the respective offers will not contain a positive fixed part: low-quality products are thus offered by manufacturers at cost. In contrast, the offer of the respective high-quality manufacturer at retailer n may contain a fixed part $T_n^i \geq 0$. When this offer is accepted, T_n is thus the profit of the high-quality manufacturer. By optimality, the specification of T_n will leave the respective retailer just indifferent between acceptance and rejection.

We now proceed as follows. We first consider the case where there is no one-stop shopping as $I = 1$, in which case our analysis closely follows that of Varian (1980) and Narasimhan (1988). As we show subsequently, the inclusion of products $i > 1$ will then be relatively immediate, so that we choose to collect our formal results once we have introduced one-stop shopping.

3.1 The Case without One-Stop Shopping ($I = 1$)

Given $I = 1$, we presently drop the superscript $i(= 1)$. Note first that given $\Delta_q > \Delta_c$, both retailers choose high quality in equilibrium. To see this, suppose to the contrary that one retailer $n \in \{1, 2\}$ would instead choose $q_n = q_L$ and some price p_n. In this case the retailer and the high-quality manufacturer could however jointly realize strictly higher profits by offering instead q_H at a price $p_n + \Delta_q$, so that this leaves consumers indifferent (and thus does not affect expected demand), while the margin would increase by $\Delta_q - \Delta_c > 0$.

Note next that with symmetric qualities, each retailer makes exactly the (gross) profits that it would realize when choosing the highest feasible price, which is $p_n = q_H$, and thereby attracting only its fraction of non-shoppers, $(1 - \lambda)/2$. Hence, we have for each retailer profits (gross of the fixed fee paid to the brand manufacturer) of $\pi = (q_H - c_H)(1 - \lambda)/2$. Intuitively, all profits that could be realized with shoppers are fully competed away in equilibrium; cf. below for the characterization of the (mixed-strategy) pricing equilibrium.

To finally determine the fixed-part of the manufacturer-retailer contract T_n (and thus the manufacturer's profits), suppose now a retailer would deviate and choose the low-quality variant. Then, its (deviating) profit becomes $\pi_d = (q_L - c_L)(1 - \lambda)/2$. By optimality for the brand manufacturer, the fixed fee T_n extracts exactly the difference between π and π_d, so that $T_n = T = (\Delta_q - \Delta_c)(1 - \lambda)/2$. The brand manufacturer thus extracts from a retailer the incremental surplus that a retailer realizes with the (non-contested) fraction of non-shoppers. As a consequence, a retailer's profit is given by the difference of $\pi = (q_H - c_H)(1-\lambda)/2$ and $T = (\Delta_q - \Delta_c)(1-\lambda)/2$, which is $(q_L - c_L)(1-\lambda)/2$. We have thus uniquely characterized the equilibrium provision of products as well as profits, which is the focus of our analysis.

For completeness, we next turn to the characterization of equilibrium prices, which is completely standard. The considered demand system does not afford an equilibrium where all retailers choose pure strategies.[20] We denote price strategies by the CDF $F_n(p_n)$ with support $p_n \in P_n$, as well as lower and upper boundaries $\underline{p}_n$ and $\overline{p}_n$, respectively. In line with the literature, we refer to choices $p_n < \overline{p}_n$ as promotions. The lower boundary $\underline{p}_n$ thus denotes the deepest promotion of retailer n. With symmetry, $\underline{p}_n = \underline{p}$ is obtained from retailers' indifference between setting $\underline{p}$ and attracting all shoppers or setting $p = q_H$ and attracting only loyal customers:

$$(\underline{p} - c_H)\Big(\frac{1-\lambda}{2} + \lambda\Big) = (q_H - c_H)\frac{1-\lambda}{2}, \tag{2}$$

which can be solved to obtain

$$\underline{p} = c_H + (q_H - c_H)\frac{1-\lambda}{1+\lambda}. \tag{3}$$

As this always strictly exceeds c_H, without one-stop shopping there is clearly no scope for below-cost pricing in equilibrium. Finally, for a retailer to be indifferent over all $p \in [\underline{p}, q_H]$, the (symmetric) pricing strategy $F_n(p_n) = F(p)$ of its rival must satisfy

$$(p - c_H)\Big[\frac{1-\lambda}{2} + \lambda(1 - F(p))\Big] = \pi.$$

Substituting $\pi = (q_H - c_H)(1-\lambda)/2$, it follows that

$$F(p) = 1 - \frac{1-\lambda}{2\lambda}\left(\frac{q_H - p}{p - c_H}\right). \tag{4}$$

Note that retailers' equilibrium pricing shifts downwards (in the sense of first-order stochastic dominance) when there are more shoppers in the market (higher λ), as does the deepest promotion $\underline{p}$ derived in (3). We postpone a formal statement of all the preceding observations (regarding qualities, profits, and prices) until we have considered also the case with $I > 1$ products (and thus, with one-stop shopping).

[20] If $p_n = p > c$ was the (symmetric) deterministic equilibrium price, a retailer that does not yet attract all shoppers would find it strictly profitable to marginally lower its price and thereby attract all shoppers. Also $p_n = c$ cannot constitute a pricing equilibrium, as each firm would have an incentive to increase its price and serve its locked-in consumers at a positive margin.

3.2 One-stop Shopping ($I > 1$)

Recall that even shoppers do not observe the offers of products $i > 1$ before entering a shop, but only that of the loss leader $i = 1$. Optimally, all retailers thus set (monopolistic) prices $p_n^i = q_n^i$ for products in all non-promoted categories $i > 1$. As consumers thus rationally anticipate that $\widehat{p}_n^i = q_n^i$ for $i > 1$, they anticipate to realize no surplus on these products. Furthermore, given $\Delta_q > \Delta_c$, it is immediate that in equilibrium, the high-quality product must be stocked in all categories $i > 1$. Finally, it is then also intuitive that the respective brand manufacturers in categories $i > 1$ can extract again the incremental surplus realized with non-shoppers, so that $T_n^i = (\Delta_q - \Delta_c)(1 - \lambda)/2$ for all $i > 1$. Hence, even though obviously retail pricing of non-promoted products is quite different from that of promoted products (cf. below), brand manufacturer profits mirror those described previously (for $I = 1$). And they are also identical to those in the promoted category $i = 1$ when now $I > 1$. While we make this precise in the proof of the subsequent proposition, it is intuitive. Irrespective of the chosen category, a brand manufacturer's bargaining power derives from the retailer's benefits from stocking the higher-quality product, which is always $\Delta_q - \Delta_c$ multiplied by the fraction of non-shoppers.

Finally, an extension of the pricing equilibrium to $I > 1$ is now also immediate, as the addition of products $i > 1$ simply increases the (gross) margin earned with each customer by $(I - 1)(q_H - c_H)$. Thus, to derive the promotional depth for general $I \geq 1$, the indifference condition (2) becomes

$$\left[(\underline{p} - c_H) + (I - 1)(q_H - c_H)\right]\left(\frac{1 - \lambda}{2} + \lambda\right) = (q_H - c_H)I\left(\frac{1 - \lambda}{2}\right), \tag{5}$$

which now solves for

$$\underline{p} = c_H + (q_H - c_H)\left[1 - I\left(\frac{2\lambda}{1 + \lambda}\right)\right]. \tag{6}$$

Promotional depth $q_H - \underline{p}$ is strictly increasing in the scope of products I that consumers purchase during their one-stop shopping trip. As $(I-1)(q_H - c_H)$ represents the additional margin earned with each attracted consumer, we obtain, with a slight change to (4),

$$F(p) = 1 - \frac{1 - \lambda}{2\lambda}\left(\frac{q_H - p}{p - c_H + (I - 1)(q_H - c_H)}\right). \tag{7}$$

As I increases, this shifts the distribution of (promoted) prices downwards in the sense of first-order stochastic dominance, thus making lower prices more likely.

We summarize our findings in the following proposition:

Proposition 1 *In the benchmark case with rational consumers, we have the following unique characterization of equilibrium product choice, profits and prices for all products* $I \geq 1$*:*

i) *Quality:* *Both for the promoted category* $i = 1$ *and for all other categories* $i > 1$*, the brand manufacturers' (high-quality) product is chosen.*

ii) *Prices:* *Non-promoted products* $i > 1$ *are always offered at prices equal to consumers' willingness to pay,* $p_n^i = q_H$*. Instead, the price for* $i = 1$ *depends on the extent of one-stop shopping (*I*) as follows: The lowest price at which it is offered in equilibrium,* $\underline{p}$ *as given by (6), is strictly decreasing in* I*, so that the depth of promotion increases. The full pricing strategy* $F(p)$ *is given by (7).*

iii) *Profits:* *At each retailer* n *and for all product categories* i*, i.e., again independent of whether* $i = 1$ *or* $i > 1$*, the respective (high-quality brand) manufacturer realizes the same profit* $\Pi_i^M = \Pi^M = (\Delta_q - \Delta_c)(1 - \lambda)/2$*. Each retailer earns* $\pi_n = (q_L - c_L)I(1 - \lambda)/2$*.*

Proof. See Appendix.

3.3 Discussion of the Benchmark Case

For the benchmark case with rational consumers, results are thus *not* consistent with the fears of brand manufacturers that profits decline when their product is deeply discounted by retailers (as a potential loss leader). We can summarize this observation as follows.

Corollary 1 *When consumers maximize expected utility (1), brand manufacturers realize the same profits irrespective of both the extent of one-stop shopping (*I*) or whether their product is used as loss leader (*$i = 1$*) or not (*$i > 1$*).*

At this point it is instructive to briefly consider an extension of the benchmark model that allows for elastic demand. We do not follow up this extension when we subsequently introduce a different choice criterion for consumers, as this would considerably complicate the analysis. To formalize the introductory remarks, however, it seems expedient to show that in the benchmark case, such elastic demand would indeed give rise to the *opposite* prediction to the aforementioned fears of manufacturers: As the extent of one-stop shopping increases and as thus promotion discounts increase, brand manufacturers become strictly better off, and the loss-leading manufacturer is strictly better off than other brand manufacturers.

Such a result would be obvious when a lower price in category $i = 1$ expanded demand only for this category, but not for other categories $i > 1$. We show however that it also applies when demand for all categories increases when the loss leader is promoted more extensively, as this increases the number of consumers frequenting the retailer altogether. We thus suppose for now that each consumer has an independently drawn reservation value for shopping: $\theta \geq 0$, with CDF $G(\theta)$. Thus, using already that consumers' rationally anticipated net surplus from all products $i > 1$ is zero, a consumer benefits from visiting retailer n only when, with respect to product $i = 1$, it holds that $q_n - p_n \geq \theta$. Given consumer surplus at retailer n, $s_n = q_n - p_n$, denote the respective maximum across retailers by $s^{\max} = \max_{n' \in N}(q_{n'} - p_{n'})$ and by $N^{\max}$ the number of retailers for which $s_n = s^{\max}$ (which is either one or two). Then demand is given by

$$D_n = G(s_n)\left(\frac{1-\lambda}{2}\right) \text{ if } s_n < s^{\max} \tag{8}$$

and by

$$D_n = G(s_n)\left[\frac{1-\lambda}{2} + \frac{\lambda}{N^{\max}}\right] \text{ if } s_n = s^{\max}, \tag{9}$$

where we assume that shoppers randomize with equal probability when indifferent, albeit this specific tie-breaking rule is inconsequential for the subsequent result. Note that in (8) the retailer does not attract any shoppers as the offered consumer surplus s_n is smaller than that of the rival retailer. For this extended model we can now show the following:

Proposition 2 *When total demand is elastic as consumers have heterogeneous reservation values for shopping, in the benchmark model the profits of brand manufacturers in the loss-leading category ($i = 1$) strictly increase in I. Moreover, the loss-leading brand manufacturers in $i = 1$ make strictly higher profits than brand manufacturers in other categories $i > 1$.*

Proof. See Appendix.

The key observation is that under elastic demand for (one-stop) shopping, now the brand manufacturer in the promoted category is strictly better off than brand manufacturers in non-promoted categories. Importantly, this result is obtained even though realized demand is the same in all categories as a deeper discount at a given retailer attracts more shoppers whose demand is however inelastic as they demand at most one unit in each category. An alternative extension could instead presume that while the number of shoppers stays constant (in the sense of a saturated market), each consumer has a downward sloping demand in each category. We can show that also in this case the manufacturer in the promoted category is strictly better off than other brand manufacturers – and only he sells strictly more units as the discount increases.[21]

4 Introducing Relative Thinking

Suppose that in category $i = 1$ retailers stock products of different quality. For ease of exposition we now briefly refer to these offers as (q_L, p_L) for the low-quality product and (q_H, p_H) for the high quality product, where $p_H > p_L$, as otherwise one offer would be dominated in all relevant aspects. Recall that under standard preferences, a consumer compares the net benefits $q_H - p_H$ and $q_L - p_L$.[22] This is our point of departure to introduce a different choice criterion. We simply refer to this as "relative thinking", as the assessment relative to some reference point is crucial, albeit it can be given different foundations, as we show next.

At the core of such relative thinking is that offers are not compared in absolute terms, but relative to some basis, which in turn depends on offers in the market. Thereby, a given price or quality difference between offers will weigh more or less depending on the prevailing offers in the market. This is indeed the crucial driver of all subsequent results. Notably, as the overall price level decreases, a given absolute price cut will weigh more relative to the case where the price level is higher. In the literature, this notion has been formalized and used in various ways. Here, we do not wish to take a particular stance in our applied contribution. However, to be specific, we offer two foundations that, for our purposes, lead to the same choice criterion. We refer to one as "pairwise relative thinking" and to the other as "salient thinking", which we both introduce next.

Pairwise relative thinking: Here, we suppose that for shoppers, who compare retailers, it is the *relative* difference in qualities and prices that matter. To make this precise, note that the offer of retailer 2 has a $100 \cdot \frac{q_H - q_L}{q_L}$ *percent* higher quality, but also a $100 \cdot \frac{p_H - p_L}{p_L}$ *percent* higher price. We stipulate that a consumer prefers the cheaper low-quality offer of retailer 1 when the difference in quality is *relatively* lower in this (percentage) sense, i.e., when

$$\frac{q_H - q_L}{q_L} < \frac{p_H - p_L}{p_L}. \tag{10}$$

[21]Again, extending the model with the subsequently introduced consumer preferences in this way is beyond the scope of this paper.

[22]For the purpose of the subsequent analysis we need not distinguish between a consumer's "true" (or "hedonic") or his "perceived" (or "normed") utility.

Reorganizing expression (10), we can likewise say that the consumer prefers the low-quality offer when

$$\frac{q_L}{p_L} > \frac{q_H}{p_H} \tag{11}$$

and the high-quality offer when the converse holds strictly. Condition (11) can now be given a slightly different wording. According to this condition, consumers compare offers in terms of the respective "quality-per-dollar" – and choose the offer that provides the highest quality-per-dollar, i.e., low quality when condition (11) holds.[23]

Salient thinking. We next provide a different formalization in terms of "salience", as applied also in Inderst and Obradovits (2020), which in turn builds on Bordalo et al. (2013). As as starting point, define now as a reference point the average price $P = \frac{p_L + p_H}{2}$ and average quality $Q = \frac{q_L + q_H}{2}$ of the two offers.[24]

Take first the low-quality product. For this product, its low price, rather than its low quality, becomes salient when

$$\frac{p_L}{P} < \frac{q_L}{Q}, \tag{12}$$

that is, when its price is *relatively* lower (in percentage terms), compared to the average price P in the consideration set, than its quality, compared again to the average quality Q. When instead the converse holds strictly, its lower quality is salient. Before discussing the implications of salience, note first that the same attribute is salient for both offers, such that when $\frac{p_L}{P} < \frac{q_L}{Q}$, this implies that also for the higher-quality product its (higher) price is salient, $\frac{p_H}{P} > \frac{q_H}{Q}$.[25] Substituting for Q and P, price is thus salient when

$$\frac{p_L}{p_H} < \frac{q_L}{q_H}, \tag{13}$$

while quality is salient when the converse holds strictly. This condition is equivalent to that in (11). While we have so far considered only the low-quality product, it is straightforward to show that the same attribute is salient also for the high-quality product, i.e., notably price when (13) holds. By stipulating that consumers compare products *only on the salient attribute*, we thus obtain exactly the same choice logic as previously.

[23]Indeed, some contributions in the literature, such as Azar (2011), start right from such a (re-)formulation.

[24]In our context, we find such a static model reasonable. Future research may want to investigate how results change under different notions of the reference-point formation, e.g., when offers are evaluated (also) relative to expected prices and qualities (then obviously with expectations formed over retailers' mixed strategies).

[25]This can be seen immediately after substituting for P and Q. This property would also extend to more than two offers (as long as strictly dominated offers are deleted from the consideration set; cf. Inderst and Obradovits 2020).

We have thus provided different ways of how to motivate consumer preferences, to which we subsequently simply refer to as relative thinking. In sum, focusing again on the question when a consumer prefers the low-quality offer (q_L, p_L) over the high-quality offer (q_H, p_H), this is the case when the respective price saving is relatively, i.e., in percentage terms, higher than the loss in quality (condition (10)), which is equivalent to the requirement that the low quality offers higher "quality-per-dollar" (condition (11)) – and this is also equivalent to the requirement that price rather than quality is salient (condition (12)), provided that the consumer then opts for the product that is superior on the salient attribute.

To conclude this discussion, we however wish to emphasize that we do not see our contribution as providing a foundation of such consumer preferences. Rather, we see ours as an applied contribution, in which the implications of such preferences are analyzed. From this perspective, we regard it as reassuring that, building on the literature, these preferences can be given different foundations – or, at least, different intuitive interpretations. Aside from answering our specific research questions, as posed in the introduction, the subsequent derivations also show that the analysis with such preferences still remains tractable, which may motivative future applications.[26]

Finally, we note that this choice logic also pertains when consumers derive a constant marginal utility from quality and maximize consumption with respect to a binding fixed budget constraint, motivated from a theory of mental accounting (Thaler 1985).[27]

In our main analysis we thus stipulate that shoppers, who observe both retailers' offers in category 1, compare these offers in such relative terms. We further follow Inderst and Obradovits (2020) and stipulate that such preferences may only distort consumers' choice at this level, that is when comparing choices that are indeed comparable along the same attributes (price and quality). Once in a shop, where such a comparison between competing

[26] Such tractability is far from obvious. In fact, most of the literature that adopts these or related preferences focuses on consumer choice alone or, in case of an analysis of firm optimality, either on perfect competition or on a single firm (i.e., in partial equilibrium). One complication of such a choice criterion is that it gives rise to a discontinuity of demand (at the point of equality for the respective conditions, e.g., the salience condition (12)). This continuity would still prevail if offers were also horizontally differentiated in the eyes of shoppers.

[27] To see this, suppose that consumers choose quantities $x_n \geq 0$ so as to maximize $\sum_{n \in N} x_n(q_n - p_n)$ subject to the (binding) category-specific resource constraint $\sum_{n \in N} x_n p_n \leq E$. As already noted, E could be motivated from a theory of mental accounting. When the constraint binds, we are indeed back to our specification of relative thinking. We note however that the multi-unit demand case is considerably more complex. While there the optimal choice is still (generically) a corner solution, with $x_n > 0$ only for the product where the respective "bang for the buck" $\frac{q_n}{p_n}$ is highest, in this case x_n depends on p_n.

retailers' offers is no longer made, a purchase is made if and only if the respective utility exceeds the consumer's reservation value (of zero). Hence, we do not suppose that also the comparison with the reservation value, which clearly cannot be assessed along the same attributes, is distorted by such relative or salient thinking.[28]

The chosen specification may seem somewhat stark in that, if one considers the interpretation of salient thinking, the non-salient attribute is basically fully discounted. As will become transparent, this heavily simplifies the subsequent analysis. That said, we have also extended the analysis to the case where such discounting occurs only gradually, where all subsequently derived insights survive. A full characterization can be requested from the authors.[29]

Overall, while we acknowledge that the examined choice rule is clearly specific, the notion of an evaluation relative to a reference point has already a long tradition in Behavioral Economics and Marketing (there, dating back at least to Monroe 1973).[30] Several authors in Marketing have also related this to Kahneman and Tversky's (1989) seminal Prospect Theory (e.g., Diamond and Sanyal 1990).[31] A recent addition to the literature are experimental and field studies that directly test implications from salience theory, such as Dertwinkel-Kalt et al. (2017) and Hastings and Shapiro (2013). Our particular focus is on a strategic environment, whereas most of the literature deals either with the optimal choice of product line for a single firm or considers perfect competition (cf. recently Apffelstaedt and Mechtenberg, forthcoming). In this literature, particularly cheap or particularly expensive (decoy) offers can be used to divert demand to other products. While there consumer choice may sometimes be modeled in a richer way, our modelling framework ensures tractability even with imperfect competition.

Finally, before proceeding to the analysis, it is important to note that, while all con-

[28]This modelling features correspond to the overarching notion that consumers do not have a fixed valuation for an offer, but that this depends on the choice context. In our particular application, the first choice context is that of selecting which store to frequent, which is based on observed promotions from all retailers. The second choice context relates to the decision in the store.

[29]Inderst and Obradovits (2020) derive results for arbitrary discounting of the non-salient attribute, though without the additional manufacturer-retailer layer that is at the core of the current analysis.

[30]We note, however, that our model of consumer choice does not incorporate "loss aversion" relative to such a reference point (see, e.g., Bell and Lattin (2000) for both a theoretical and empirical consideration of such preferences).

[31]Much of the literature in Marketing has however focused on how a single firm's offers can shape consumer perceptions. For example, Huber et al. (1982) show that the choice among two alternatives can crucially be affected if a third, dominated alternative is added (the so-called "attraction effect"). Similarly, Simonson (1989) demonstrates that adding an alternative that is particularly good on one dimension, but bad on another (e.g., a product with very high quality, but also a very high price), may tilt consumers' choice among the initially available alternatives ("compromise effect").

sumers are potentially prone to such a bias (that is, of relative or salient thinking), the distorted choice rule becomes effective only for shoppers, as only their consideration set contains competing offers. Thus, as the fraction of shoppers in the market increases, also the bias becomes more prevalent.

5 Analysis with Relative Thinking

5.1 A First Look at the Main Mechanism

While in the benchmark case retailers stocked brand manufacturers' products in all categories, we show that with relative thinking this may no longer be the case. In this section, however, we still focus on the case where also in $i = 1$ the product is supplied by brand manufacturers, but we show that their profits may be lower and strictly decreasing in the promotional discount.

Clearly, with $q_n = q_H$ for all $n \in N$, relative thinking does not matter *on equilibrium*. Still, as we show, it affects the profitability of a retailer's strategy to deviate and stock the low-quality product. This affects both manufacturer profits and the condition for when the high-quality equilibrium exists.

Consider thus a deviating retailer n choosing $q_n = q_L$ and some price that we denote by $p_n = p_L$, which shoppers thus compare with the high-quality offer at some price p_H. To attract shoppers, p_L must satisfy (13). Recall that we have also derived this in terms of relative differences, i.e., that the respective price difference must be larger in percentage terms compared to the difference in qualities. But when the price level, here the rival's price p_H, is low, to achieve the same percentage effect, p_L needs to undercut p_H by less in *absolute terms*. This is precisely how one-stop shopping affects the profitability of a price reduction: Under one-stop shopping, the price level and thus, with mixed strategies, also any possible price of the high-quality rival decrease, as any attracted shopper becomes more profitable, given the basket of products that he buys at each trip. Through this mechanism one-stop shopping and the resulting discounting of prices attenuates quality differences, which, as we next derive formally, may reduce brand manufacturers' bargaining position and profits.

5.2 Implications for Brand Manufacturer Profits

Suppose both retailers still stock the high-quality product also in the loss-leading category. We first analyze when this is indeed still an equilibrium. In the main text, we provide an intuition for the derivation of this threshold in terms of the extent of one-stop shopping.

We show in the proof of Proposition 3 that if a retailer instead deviates and stocks the low-quality product, he finds it optimal to price sufficiently low so as to capture the shoppers with probability one. Let now $\underline{p}$ denote, as previously, the lower bound of the pricing support in category $i = 1$ of the rival. With relative thinking we know from condition (13) that the retailer's low price in category 1, p_L, must then satisfy

$$\frac{p_L}{\underline{p}} < \frac{q_L}{q_H}. \tag{14}$$

Suppose now that so as to avoid being delisted, the brand manufacturer would be prepared to make zero profits, thereby offering the high-quality product at costs c_H (and thus setting $T_n = 0$ for the respective retailer). The (potentially deviating) retailer would thus have the option to either procure the low-quality or the high-quality offer at costs. This makes his deliberation of which product to provide so as to attract the shoppers particularly simple: We only need to compare the respective per-consumer margin $p_L - c_L$ under the low-quality deviation with that of offering the high-quality product at the lower boundary of the support and thus with a margin of $\underline{p} - c_H$. Hence, the deviation would be strictly optimal when $p_L - c_L > \underline{p} - c_H$, where we next substitute for $p_L = \underline{p}\frac{q_L}{q_H}$ by imposing equality in (14)[32]

$$\underline{p}\frac{q_L}{q_H} - c_L > \underline{p} - c_H \iff \underline{p} < \frac{\Delta_c}{\Delta_q} q_H. \tag{15}$$

Recall that $\frac{\Delta_c}{\Delta_q} < 1$ as $\Delta_q > \Delta_c$. Hence, a deviation to low quality is optimal for a retailer if and only if the price level, as expressed by the lower boundary $\underline{p}$, is sufficiently low, so that (15) holds. In the following section, we expand on this.

When the converse of condition (15) holds, such a deviation to offering low quality is instead not optimal for a retailer even in category $i = 1$. Then, the equilibrium where both retailers arrive at a mutually beneficial agreement also with the brand manufacturers in $i = 1$ still exists.

We now express the converse of condition (15) in terms of the degree of one-stop shopping, after substituting for $\underline{p}$:

$$I \leq \tilde{I} \equiv \frac{q_H}{\Delta_q}\left(\frac{\Delta_q - \Delta_c}{q_H - c_H}\right)\frac{1+\lambda}{2\lambda}. \tag{16}$$

[32]Note that we do not thereby suppose that at equality a consumer chooses the low-quality offer with probability one (or, taking the interpretation of salience, that (low) price becomes salient). It is sufficient that this is the case when the inequality is "just" satisfied.

Note again that the right-hand side of this inequality is strictly positive as $\Delta_q > \Delta_c$. When this condition holds, we obtain the following key result:

Proposition 3 *Suppose consumers are relative thinkers. Then, if (16) holds, brand manufacturers' (high-quality) products are still supplied in all categories. Suppliers of products in the loss-leading category $i = 1$, however, now realize strictly lower profits than suppliers in categories $i > 1$ if the extent of one-stop shopping I (and thus the promotional discount) I is sufficiently large, with*

$$I > \widehat{I} \equiv \frac{q_H}{\Delta_q}\left(\frac{\Delta_q - \Delta_c}{q_H - c_H}\right). \tag{17}$$

In this case, the loss-leading suppliers' profits are also strictly decreasing in the extent of one-stop shopping and thereby the promotional discount of their products.

Proof. See Appendix.

To add more intuition, note first that $\widehat{I} < \tilde{I}$, so that there is indeed an interval of values I where the brand manufacturers' products are still listed also in $i = 1$, but where profits are strictly lower than those of brand manufacturers in other categories. As we can show, at $I = \tilde{I}$, manufacturers' profits in $i = 1$ fall down to zero, which is precisely the point from where on (i.e., for higher I) their products will be delisted (with positive probability). We discuss the respective equilibrium in the following subsection. We now elaborate on manufacturer profits.

Recall that, independently of the extent of one-stop shopping, suppliers in categories $i > 1$ make profits of $\Pi^M = (\Delta_q - \Delta_c)(1 - \lambda)/2$, reflecting the part of their value-added that is not competed away downstream. In the proof of Proposition 3, we derive explicitly the profit differential between suppliers in categories $i > 1$ and the loss-leading suppliers. This can be expressed as follows:

$$\Pi^M_{i>1} - \Pi^M_1 = \frac{1+\lambda}{2}(\Delta_q - \Delta_c) - I\lambda\frac{\Delta_q}{q_H}(q_H - c_H). \tag{18}$$

Note that the first term, with factor $(1 + \lambda)/2$, is not a typo, but obtained from collecting terms. The total expression is indeed strictly decreasing in λ for the considered parameters where (18) is positive. We also see immediately that a loss-leading manufacturer's profit is strictly decreasing in the extent of one-stop shopping, I, as asserted in Proposition 3. Figure 1 illustrates this dependency, together with a comparison of profits for manufacturers in category $i = 1$ and in all other categories $i > 1$. There, for greater transparency, parameters have been chosen such that at $I = 2$ profits exactly coincide. The comparative profit loss $\Pi^M_{i>1} - \Pi^M_1$ of a loss-leading brand manufacturer then increases strictly in I (in a linear fashion, as follows from (18)) until it is maximal at $I = \tilde{I}$. From there on, as we show below, brand manufacturers' profits in $i = 1$ remain at zero and the brand will be delisted with strictly positive probability.

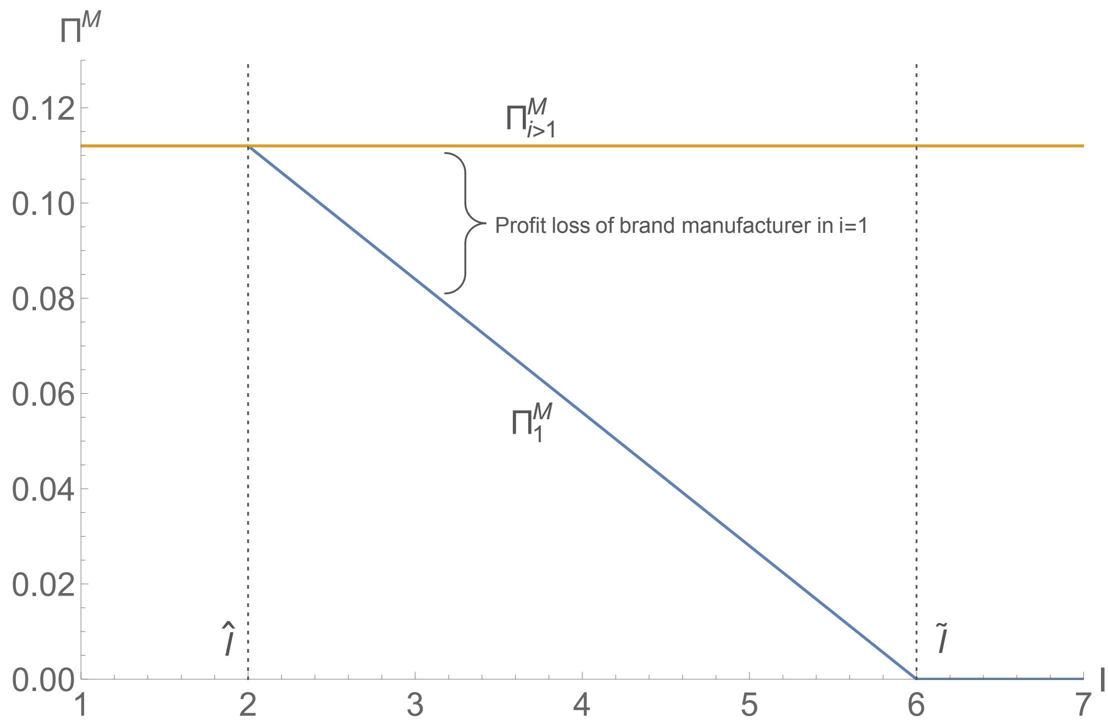

Figure 1: Manufacturer profits as a function of I. The parameters used are $q_H = 1$, $c_H = 0.6$, $q_L = 0.65$, $c_L = 0.53$, $\lambda = 0.2$.

In Figure 2 we compare profits in terms of λ. This parameter has two intertwined roles in our model. The implications of relative thinking obviously become more pronounced if λ increases, simply as only shoppers compare the offers in category $i = 1$ across retailers. This is the first reason why λ affects also the comparison of manufacturer profits in different categories. Further, as λ increases, the price level decreases for the loss-leading product. With relative thinking, a lower price level makes it cheaper to attract shoppers with a low-quality offer, which increases the outside option of a retailer when $I > \widehat{I}$, as we have discussed before. For these two reasons the profit loss of a brand manufacturer in $i = 1$ relative to brand manufacturers in $i > 1$ increases in λ for $I > \widehat{I}$, as depicted in Figure 2. With increasing competition at the retail level, all profits clearly decrease, but the decrease is more pronounced for the loss-leading category. Again, we have $\Pi^M_1 = 0$ from a certain level of $\lambda < 1$ onwards, where still $\Pi^M_{i>1} > 0$, as then the branded product will be delisted with positive probability in category $i = 1$. In sum, regardless of the reason why retail competition intensifies in our model, a loss-leading brand manufacturer is affected strictly more than manufacturers in other categories.

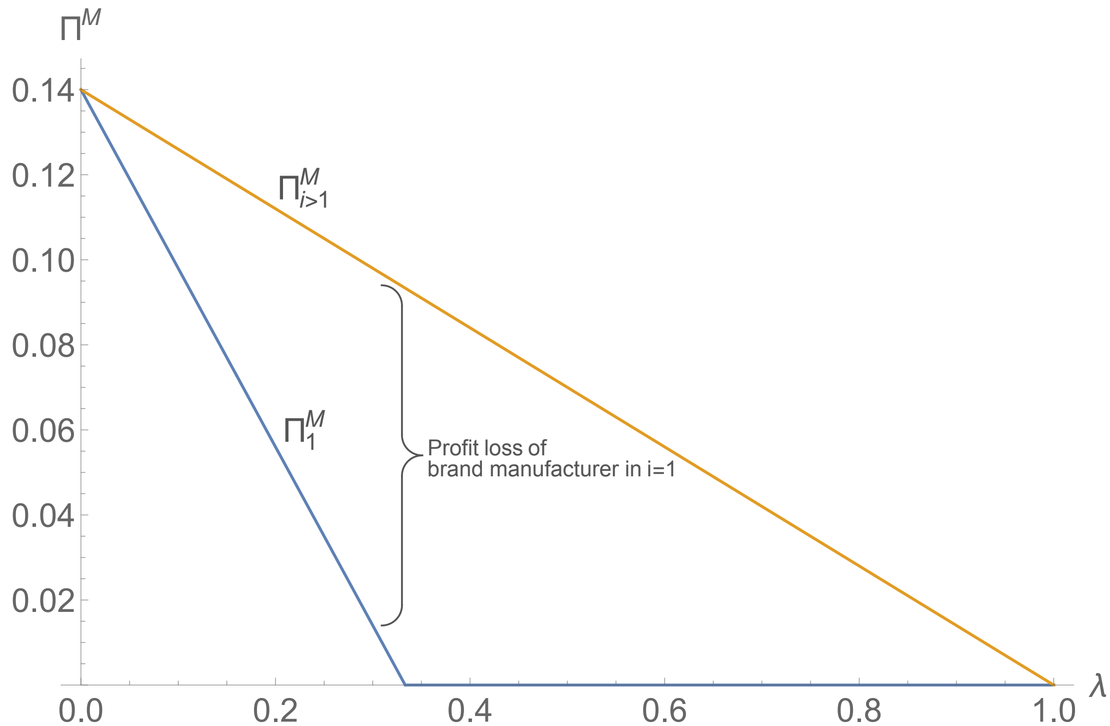

Figure 2: Manufacturer profits as a function of λ. The parameters used are $q_H = 1$, $c_H = 0.6$, $q_L = 0.65$, $c_L = 0.53$, $I = 4$.

When consumers exhibit relative thinking, deep discounting and loss leading thus indeed hurt brand manufacturers, even when their products are still listed. They should thus be particularly aware of the implications of intensifying retail competition. This is even more so as the preceding discussion also suggests that, when such loss leading becomes sufficiently extensive, brand manufacturers may find their products delisted. For completeness, we finally turn to this case.

5.3 The Threat of Being Delisted

When (16) no longer holds as I is too large, an equilibrium where both retailers always stock the brand manufacturers' product also in the loss-leading category no longer exists. This is what we have already shown.

Note next that there can also not be an equilibrium where both retailers for sure choose the low-quality (i.e., possibly store-brand) product in category $i = 1$. As profits from shoppers are always fully competed away, the resulting (equilibrium) profits would be strictly lower than when stocking a brand manufacturer's product in $i = 1$ (at cost) and targeting only non-shoppers.[33] Hence, the equilibrium for product choice in the promoted category must be in mixed strategies. We provide a characterization of the respective probabilities in the proof of the subsequent proposition. There, we also characterize the mixed pricing strategies.

Proposition 4 *Suppose (16) does not hold. While brand manufacturers' profits in all other categories $i > 1$ are not affected, the brand manufacturers in the loss-leading category make zero profit. With positive probability their products are no longer listed, and this probability is higher when the extent of one-stop shopping I and thus discounts are larger.*

Proof. See Appendix.

In our model, retailer discounting of a manufacturer's own brand does not hurt the manufacturer directly. In fact, such a direct impact on brand image might be more relevant in the case of luxury goods, to which our model of sales and promotions may be less applicable. Instead, in our model it is the overall lower price level that affects, via consumers' relative thinking, the relative perception of quality and price. As a consequence, unless one brand manufacturer would virtually control the branded supply in a given category, here $i = 1$, and could commit to impose a higher shelf price at all competing retailers, a single manufacturer can not successfully lean against loss leading and its negative implications for all suppliers of branded products in the given category. This insight can also be framed as follows. Consider just for now the image of competing vertical chains – or, likewise, that of forward integrated manufacturers, who still face downstream competition. Then, in any such vertical chain, downstream pricing and aggregate profits would remain the same as in our analysis. And the same applies to the provision of high- versus low-quality products. While such a picture is helpful to stress why an individual branded goods manufacturer could not escape the described pitfall of low prices, for our key result on the distribution of profits in the vertical chain it was necessary to consider retailers and manufacturers separately. In our concluding remarks we now elaborate on additional implications.

[33] In fact, the increase in profits resulting from such a deviation from the candidate equilibrium would be $(\Delta_q - \Delta_c)(1 - \lambda)/2$.

6 Conclusion

Our main empirical motivation comes from the observation that brand manufacturers, notably of FMCG products, seem to resent retailers' practice to heavily discount prices of their products. As this should increase demand and as it is not obvious why manufacturers should co-fund such promotions, this is at first puzzling. Our main result is therefore a precise, formal derivation of the possible channel which explains this relationship. From this we derive various implications, on which we now further expand.

We first recall the two main features of our model. First, with one-stop shopping consumers base their choice of retailers only on the comparison of a selected number of products. These are consequently the products on which price competition is fiercest. Second, the relative weight that consumers give to different attributes of a product, here price and quality, may depend on market circumstances, precisely on the relative difference to other offers in the market. Our analysis captures these two features by combining a model of one-stop stopping, set into a model of sales (Varian 1980), with insights from the Marketing and Behavioral Economics literature on consumers' relative perception of quality and prices ("relative thinking"). Our main focus is on the implications for the vertical layer, notably brand manufacturers' profits.

The role of consumer preferences is crucial, as an increase in the extent of one-stop shopping will only negatively affect manufacturer profits with relative thinking and not with standard preferences. And this is the case only in the promoted (loss leading) category. Thus, when consumers exhibit such relative thinking, but not so otherwise, we can indeed support manufacturers' concerns when retailers discount the respective product category to compete for one-stop shoppers.

Brand manufacturers may have little influence on whether their product belongs to a loss-leading category or not, which may depend, for instance, on whether it represents a staple product that most households demand. Still, management can learn the following from our analysis. Unless a manufacturer virtually controls the supply of branded products in a given category, unilateral strategies of retail price maintenance, imposed either directly or indirectly through the threat of withdrawing supply, can not shore up manufacturers' profits. This is because it is the overall low price level in the promoted category that affects consumers' preferences over prices and quality. Instead, manufacturers would benefit when, for instance, an industry-wide ban or restriction of loss leading was imposed, as it is the case in some countries (at least for food retailing). If this is not the case and when the category into which their main products fall is a typical loss leader, they should watch out more carefully than other brand manufacturers for trends in retailing that could lead to intensified retail competition. Looking backwards, this may indeed apply to the rise of one-stop shopping. Looking into the future, online shopping even for staple grocery products may further increase retail competition. In addition, online promotions of only few items could increase the prominence of loss-leading strategies. When management anticipates such changes, the return from an investment in brand value might fall. Then, it may be more profitable to direct investments into cutting costs. We plan to explore such longer-term strategic considerations of our model in future work.

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8 Appendix: Proofs

Proof of Proposition 1. To streamline the exposition of the proof, we first recognize that, by the arguments in the main text, each retailer will stock high quality at categories $i > 1$ and that the corresponding prices equal the respective valuation q_H. We next consider $i = 1$.

We argue to a contradiction and suppose $q_n = q_L$ (suppressing for now the index for $i = 1$). We next write expected demand at each retailer as a function of consumers' (perceived) net surplus s_n, which is $s_n = q_L - p_n$, given the anticipated monopolistic pricing at all products $i > 1$. Given the anticipated strategies at all other retailers $n' \neq n$, in an equilibrium retailer n faces some expected demand $X_n(s_n)$ (which, at this point, we need not derive explicitly). Take now some equilibrium price p_n (i.e., a price for $i = 1$ in the respective support of retailer n) and expected demand $X_n(q_L - p_n)$. Consider a deviation to $q_n = q_H$ and the choice of a price $\widehat{p}_n = p_n + \Delta_q$, which thus realizes the same expected demand. In case the high-quality manufacturer offered his product at the wholesale price $w_n = c_H$, the retailer's increase in profit (gross of T_n) would then be at least

$$\varkappa = \frac{1-\lambda}{N}(\Delta_q - \Delta_c) > 0.$$

By setting $T_n = \varkappa/2$ the respective high-quality manufacturer can thus ensure that its (deviating) offer is accepted for sure and that it generates strictly positive profits, which results in a contradiction to the claim that retailer n offers low quality for product $i = 1$.

We next turn to wholesale contracts. We wish to support an equilibrium where marginal wholesale prices equal marginal costs. Take first $i = 1$ and note that, at retailer n, the respective price p_n^1, where we now make the dependency on $i = 1$ explicit, then maximizes

$$\left[(p_n^1 - w_n^1) + (I-1)(q_H - c_H)\right] X_n(q_H - p_n^1), \tag{19}$$

so that joint profits of retailer n and the respective high-quality manufacturer are clearly maximized when $w_n^1 = c_H$. This extends also to the providers of products $i > 1$ as follows. Then, the respective objective function of the retailer equals

$$\left[(p_n^1 - c_H) + (I-2)(q_H - c_H) + (q_H - w_n^i)\right] X_n(q_H - p_n^1), \tag{20}$$

which equals that in (19).

Next, given marginal wholesale prices equal to marginal manufacturer costs, the determination of fixed fees follows from the argument in the main text as follows. For this we show that when a retailer rejects the offer of the high-quality manufacturer of any category i, the deviation profit, gross of the fixed fees T_n^j for all other manufacturers j, is obtained by attracting only the respective locked-in fraction of consumers. We show this first when $i = 1$. Consider generally any two levels of net utility that a retailer may offer to consumers, $s' < s''$. We show that when offering s' is weakly preferred for a retailer that (on-equilibrium) chooses $q_n^1 = q_H$, offering the lower net utility is strictly preferred when the retailer deviates to $q_n = q_L$. Formally: Making use of the expression $X_n(s)$ for expected demand, as well as prices $p'_H = q_H - s'$ and $p''_H = q_H - s''$ with high quality and prices $p'_L = q_L - s'$ and $p''_L = q_L - s''$ with low quality, we claim that

$$[(q_H - s' - c_H) + (I-1)(q_H - c_H)]\, X_n(s') \geq [(q_H - s'' - c_H) + (I-1)(q_H - c_H)]\, X_n(s'')$$

implies

$$[(q_L - s' - c_L) + (I-1)(q_H - c_H)]\, X_n(s') > [(q_L - s'' - c_L) + (I-1)(q_H - c_H)]\, X_n(s''),$$

which indeed holds from $\Delta_q > \Delta_c$.[34] As we already know that offering zero net utility ($p_n = q_H$) yields the equilibrium profits, offering zero net utility (now $p_n = q_L$) must then indeed be uniquely optimal when deviating to $q_N = q_L$. From the respective expressions for π, we then obtain from a retailer's indifference, which must hold by optimality for the manufacturer, that

$$T_n^1 = (\Delta_q - \Delta_c)\frac{1-\lambda}{2}.$$

We can now apply this argument also to all categories $i > 1$, after noting the equivalence of the respective expressions as used already when we compared (19) with (20). **Q.E.D.**

Proof of Proposition 2. The equilibrium characterization is a straightforward extension from the case where consumers all have the same reservation value of shopping (of zero). We thus already make use of the observations that, first, for all products the high quality

[34] More precisely, when we impose equality on the first condition, we can write this as

$$\begin{aligned}
&[(q_L - s' - c_L + [(q_H - c_H) - (q_L - c_L)]) + (I-1)(q_H - c_H)]\, X_n(s') = \\
&[(q_L - s'' - c_L + [(q_H - c_H) - (q_L - c_L)]) + (I-1)(q_H - c_H)]\, X_n(s''), \text{ i.e.,} \\
&[(q_L - s' - c_L) + (I-1)(q_H - c_H)]\, X_n(s') = \\
&[(q_L - s'' - c_L) + (I-1)(q_H - c_H)]\, X_n(s'') + (\Delta_q - \Delta_c)\, [X_n(s'') - X_n(s')]\,.
\end{aligned}$$

From this, our second inequality follows as $\Delta_q > \Delta_c$ and as clearly $X_n(s'') > X_n(s')$.

is stocked and, second, there is an equilibrium where marginal wholesale prices equal marginal costs.

Observe next that a retailer's expected (gross) profit with any non-shopping local consumer is

$$\pi = (p - c_H + (I-1)(q_H - c_H))G(q_H - p). \tag{21}$$

We suppose for convenience that g/G is weakly increasing in its argument, so that $p^m = \arg\max_p \pi$ is uniquely determined and results in (per-consumer) expected profits of π^m. Thus, when a retailer only attracts non-shoppers, then the maximum profit is $\frac{1-\lambda}{2}\pi^m$ (gross of any fixed fee paid to the manufacturer).

We turn now to the derivation of manufacturer profits. Take $i = 1$ with respective profits Π_1^M. From the respective indifference condition for each retailer, we now have

$$\Pi_1^M = \frac{1-\lambda}{2}\left(\pi_H^m - \pi_L^m\right),$$

where we extended the notation in (21) as follows: π_H^m denotes the maximum profit when the retailer stocks q_H at cost c_H and π_L^m is the respective maximum profit when the retailer instead stocks q_L at cost c_L. Using uniqueness of the respective prices p_H^M an p_L^M and appealing to the envelope theorem, we have that

$$\frac{d\Pi_1^M}{dI} = (q_H - c_H)\frac{1-\lambda}{2}\left[G(q_H - p_H^m) - G(q_L - p_L^m)\right].$$

To show that profits increase with the extent of one-stop shopping, it thus remains to prove that

$$p_H^m - p_L^m < \Delta_q. \tag{22}$$

To see this, it is now convenient to denote more generally $p^m(q, c)$ as the "monopoly price" when, at $i = 1$, quality q is stocked at cost c. With this we rewrite

$$\begin{aligned} p_L^m &= \arg\max_p \left[(p - c_L + (I-1)(q_H - c_H))G(q_L - p)\right] \\ &= \arg\max_p ((p - \Delta_q) - c_L + (I-1)(q_H - c_H))G(q_L - (p - \Delta_q)) - \Delta_q \\ &= p^m(q_H, \Delta_q + c_L) - \Delta_q. \end{aligned}$$

Hence, the requirement (22) transforms to

$$p_H^m = p^m(q_H, c_H) < p^m(q_H, \Delta_q + c_L),$$

which follows as, when this is interior for a non-degenerate $G(\cdot)$, $\partial p^m(q, c)/\partial c > 0$ and as $\Delta_q + c_L > c_H$ from $\Delta_q > \Delta_c$.

With respect to manufacturer profits, it remains to prove that, with elastic demand, $\Pi_1^M > \Pi_i^M$ for $i > 1$. To see this, we have to derive Π_i^M, appealing again to retailer indifference. For this we make again use of expression (21) as follows. On equilibrium, the retailer's gross profits are $\frac{1-\lambda}{2}\pi^m$. Off equilibrium, after rejecting the offer of one manufacturer in some category $i > 1$, the retailer's maximum profits are again obtained by targeting only non-shoppers and choosing the respective optimal "monopoly" price p, thereby now realizing (per consumer)

$$\max_p (p - c_H + (I-2)(q_H - c_H) + (q_L - c_L))G(q_H - p).$$

We denote these per-consumer profits by $\pi_{H,L}^m$, indicating that high quality is offered in category 1 (as well as in $I-2$ additional categories), while in one (non loss-leading) category low quality is offered. Consequently, we have for $i > 1$

$$\Pi_i^M = \frac{1-\lambda}{2}\left(\pi_H^m - \pi_{H,L}^m\right),$$

so that $\Pi_1^M > \Pi_i^M$ holds if $\pi_{H,L}^m > \pi_L^m$, i.e. if

$$\begin{aligned} & \max_p (p - c_H + (I-1)(q_H - c_H))G(q_L - p) \\ < \; & \max_p (p - c_H + (I-2)(q_H - c_H) + (q_L - c_L))G(q_H - p). \end{aligned} \tag{23}$$

Recall that the maximizer of the first expression is denoted by p_L^m. Clearly, the second expression is bounded from below when we substitute some price $p' = p_L^m + \Delta_q$, so that $G(q_H - p')$ equals $G(q_L - p_L^m)$. Note finally that for this price choice we have

$$\begin{aligned} & p' - c_H + (I-2)(q_H - c_H) + (q_L - c_L) \\ = \; & p_L^m - c_H + (I-1)(q_H - c_H). \end{aligned}$$

For completeness we finally extend our characterization of the pricing equilibrium. Both retailers randomize according to some continuous CDF $F(p)$ over the support $p \in [\underline{p}, p^m]$. A retailer choosing $p = \underline{p}$ can be certain to sell to all shoppers whose reservation value is sufficiently low, while with $p = p^m$ the retailer sells only to its local non-shoppers (with sufficiently low reservation value). To make the retailer indifferent between these two choices, $\underline{p}$ must satisfy

$$\left(\frac{1-\lambda}{2} + \lambda\right)(\underline{p} - c_H + (I-1)(q_H - c_H))G(q_H - \underline{p}) = \frac{1-\lambda}{2}\pi^m, \tag{24}$$

while the distribution $F(p)$ is finally obtained from the requirement to make each retailer indifferent also with respect to all $p \in (\underline{p}, p^m)$:

$$F(p) = 1 - \frac{1-\lambda}{2\lambda}\left[\frac{\pi^m}{(p - c_H + (I-1)(q_H - c_H))G(q_H - p)} - 1\right]. \tag{25}$$

Q.E.D.

Proof of Proposition 3. We first consider a candidate equilibrium of high quality in all categories. For this we determine a retailer's deviation profits. Suppose thus that retailer n, instead of choosing $q_n = q_H$ in category $i = 1$, deviates to $q_n = q_L$. Then, given the rival retailer's anticipated choice of $q_{n'} = q_H$ in the same category and the corresponding product price drawn from $F(\cdot)$, as given in (7), when setting an arbitrary price p_L retailer n makes an expected deviation gross profit of

$$\begin{aligned}\pi_n(p_L; q_L) &= [p_L - c_L + (I-1)(q_H - c_H)]\left[\frac{1-\lambda}{2} + \lambda\Big(1 - F\big(p_L \frac{q_H}{q_L}\big)\Big)\right] \\ &= \frac{[p_L - c_L + (I-1)(q_H - c_H)]\frac{1-\lambda}{2} I(q_H - c_H)}{\frac{q_H}{q_L} p_L - c_H + (I-1)(q_H - c_H)},\end{aligned}$$

where the second equality follows from inserting $F(\cdot)$, and simplifying. It now holds that $\frac{\partial \pi_n(p_L;q_L)}{\partial p_L}$ has the same sign as

$$\eta(I) \equiv \frac{q_H}{q_L} c_L - c_H - (I-1)(q_H - c_H)\frac{\Delta q}{q_L},$$

which is, in particular, independent of p_L. Hence, the deviation gross profit $\pi_n(p_L; q_L)$ is monotonic in p_L. If $\eta(I) \geq 0$, which is equivalent to

$$I \leq \frac{q_H}{\Delta_q}\left(\frac{\Delta_q - \Delta_c}{q_H - c_H}\right) = \widehat{I},$$

the optimal deviation price is the highest feasible price $p_L = q_L$, yielding thus a maximal deviation gross profit of

$$\pi_n(q_L; q_L) = [q_L - c_L + (I-1)(q_H - c_H)]\frac{1-\lambda}{2}.$$

If instead $\eta(I) < 0$ $(I > \widehat{I})$, the optimal deviation price is $\frac{q_L}{q_H}\underline{p}$, which guarantees that all shoppers are attracted. The corresponding deviation gross profit is then

$$\pi_n(\frac{q_L}{q_H}\underline{p}; q_L) = [\frac{q_L}{q_H}\underline{p} - c_L + (I-1)(q_H - c_H)]\frac{1+\lambda}{2}.$$

Depending on the sign of $\eta(I)$, or likewise on how I compares to the threshold $\widehat{I}$, we have thus derived the optimal deviation pricing strategy and from this corresponding profits when a retailer deviates to q_L in category $i = 1$. Recall now that a brand manufacturer in $i = 1$ can extract as fixed fee (and thereby, profit) the difference of the retailer's gross profit when stocking q_H at the marginal wholesale price c_H,

$$\pi_n(q_H) = (q_H - c_H)I\frac{1-\lambda}{2} = [\underline{p} - c_H + (I-1)(q_H - c_H)]\frac{1+\lambda}{2},$$

and the retailer's maximal deviation profit. Hence, when $I \leq \widehat{I}$, the brand manufacturer of $i = 1$ makes a profit of

$$\begin{aligned}\Pi_1^M &= (q_H - c_H)I\frac{1-\lambda}{2} - [q_L - c_L + (I-1)(q_H - c_H)]\frac{1-\lambda}{2} \\ &= (\Delta_q - \Delta_c)\frac{1-\lambda}{2},\end{aligned}$$

i.e., the same as other brand manufacturers. But when $I > \widehat{I}$, the brand manufacturer of $i = 1$ makes a profit of

$$\begin{aligned}\Pi_1^M &= [\underline{p} - c_H + (I-1)(q_H - c_H)]\frac{1+\lambda}{2} - [\frac{q_L}{q_H}\underline{p} - c_L + (I-1)(q_H - c_H)]\frac{1+\lambda}{2} \\ &= \frac{1+\lambda}{2}(\Delta_q - \Delta_c) - I\lambda\frac{\Delta_q}{q_H}(q_H - c_H),\end{aligned}$$

which is strictly lower than other brand manufacturers' profits of $(\Delta_q - \Delta_c)\frac{1-\lambda}{2}$. Moreover, in this case Π_1^M is clearly strictly decreasing in I, as claimed.

Note finally that from the preceding derivation of a deviating retailer's maximum profits, we immediately obtain the respective equilibrium condition (16). **Q.E.D.**

Proof of Proposition 4. In what follows, we provide a full characterization of the equilibrium strategies, which implies the statements in the proposition.

Lemma 1 *If the converse of (16) holds such that $I > \tilde{I}$, no equilibrium exists in which both retailers stock the branded product or the low-quality product in category $i = 1$ with probability one. There exists a unique symmetric equilibrium involving mixed product strategies such that either retailer stocks the branded product in $i = 1$ with probability*

$$\alpha^* = \frac{1-\lambda}{2\lambda}\left[\frac{(\Delta_q - \Delta_c)q_H}{(I-1)(q_H - c_H)\Delta_q + q_L c_H - q_H c_L}\right] \in (0,1),$$

where $\alpha^*(\tilde{I}) = 1$ and $\alpha^*(I)$ strictly decreases as the extent of one-stop shopping I increases. The equilibrium pricing strategies are as follows. Conditional on stocking q_H in $i = 1$, a *retailers draws his price in $i = 1$ from the CDF*

$$F_H(p_H) = 1 - \frac{1}{\alpha^*}\left[\frac{1-\lambda}{2\lambda}\left(\frac{q_H - p_H}{p_H - c_H + (I-1)(q_H - c_H)}\right)\right] \tag{26}$$

with support

$$[\underline{p}_H, \overline{p}_H] = \left[\frac{\Delta_c}{\Delta_q} q_H, q_H\right].$$

Conditional on stocking q_L in $i = 1$, a retailer draws his price in $i = 1$ from the CDF

$$F_L(p_L) = \frac{1 - \frac{1-\lambda}{2\lambda}\left(\frac{q_H - \Delta_c - p_L}{p_L - c_L + (I-1)(q_H - c_H)}\right)}{1 - \alpha^*} \tag{27}$$

with support

$$[\underline{p}_L, \overline{p}_L] = \left[\underline{p} - \Delta_c, \frac{\Delta_c}{\Delta_q} q_L\right],$$

where $\underline{p}$ is given in (6). In this equilibrium, brand manufacturers in $i = 1$ charge no fixed fee and consequently make zero profit.

Proof. Recall from the main text that for $I > \tilde{I}$ no equilibrium exists in which both retailers stock the branded product in $i = 1$ for sure or where both retailers stock the low-quality quality product in $i = 1$ for sure. In what follows, we confine ourselves to proving existence of the outlined symmetric mixed-strategy equilibrium in product choice (and pricing). The proof for why this is also the unique symmetric equilibrium is slightly more subtle and is available from the authors upon request.

For existence, note first that when retailers stock different products in $i = 1$ in the candidate equilibrium, then firms' price distributions are such that $q_H/p_H < q_L/p_L$ with probability one (as $q_H/\underline{p}_H = q_L/\overline{p}_L$, $p_H \geq \underline{p}_H$ and $p_L \leq \overline{p}_L$). Hence, a retailer stocking q_H in $i = 1$ (at marginal wholesale price c_H) and setting some price $p_H \in [\underline{p}_H, \overline{p}_H]$ only attracts the shoppers if its rival stocks the high-quality product as well and chooses a price higher than p_H (joint probability $\alpha^*(1 - F_H(p_H))$). Therefore, such a retailer's expected gross profit is given by

$$\begin{aligned}\pi_n(p_H; q_H) &= [p_H - c_H + (I-1)(q_H - c_H)]\left[\frac{1-\lambda}{2} + \lambda\alpha^*(1 - F_H(p_H))\right] \\ &= (q_H - c_H)I\left(\frac{1-\lambda}{2}\right),\end{aligned}$$

where the second equality follows from inserting $F_H(\cdot)$, and simplifying. If instead a retailer stocks q_L in $i = 1$ and sets some price $p_L \in [\underline{p}_L, \overline{p}_L]$, the retailer attracts the shoppers whenever the rival stocks q_H in $i = 1$ (probability α^*) or when the rival stocks

q_L in $i = 1$ and chooses a price higher than p_L (joint probability $(1-\alpha^*)(1-F_L(p_L))$). Therefore, such a retailer's expected gross profit is given by

$$\begin{aligned}\pi_n(p_L; q_L) &= [p_L - c_L + (I-1)(q_H - c_H)] \left\{ \frac{1-\lambda}{2} + \lambda \left[\alpha^* + (1-\alpha^*)(1-F_L(p_L))\right] \right\} \\ &= [p_L - c_L + (I-1)(q_H - c_H)] \left\{ \frac{1-\lambda}{2} + \lambda \left[1 - (1-\alpha^*)F_L(p_L)\right] \right\} \\ &= (q_H - c_H) I \Big(\frac{1-\lambda}{2} \Big) = \pi_n(p_H; q_H),\end{aligned}$$

where the second equality follows from inserting $F_L(\cdot)$, and simplifying. As a first implication, note that the retailers are indeed indifferent between stocking q_H in $i = 1$ and setting any price $p_H \in [\underline{p}_H, \overline{p}_H]$, or stocking q_L in $i = 1$ and setting any price $p_L \in [\underline{p}_L, \overline{p}_L]$. A further implication from this indifference is that brand manufacturers can indeed not charge a positive fixed fee. Further, retailers can not profitably deviate by stocking q_H in $i = 1$ and pricing above $\overline{p}_H = q_H$ (as this would imply zero demand) or stocking q_L in $i = 1$ and pricing below $\underline{p}_L$ (as already by setting $p_L = \underline{p}_L$, the shoppers are attracted with certainty). It remains to show that the retailers do not wish to deviate by stocking q_H in $i = 1$ and pricing strictly below $\underline{p}_H$ (giving them a chance to attract the shoppers even when the rival stocks q_L in $i = 1$) or by stocking q_L in $i = 1$ and pricing strictly above $\underline{p}_L$ (risking to lose the shoppers also when the rival chooses q_H in $i = 1$, but realizing a higher margin on each sale of $i = 1$). We prove this next.

To see the former, note that for $p_H < \underline{p}_H$ a retailer's expected gross profit is given by

$$\pi_n(p_H; q_H) = [p_H - c_H + (I-1)(q_H - c_H)] \left[\frac{1+\lambda}{2} - \lambda(1-\alpha^*) F_L\big(p_H \frac{q_L}{q_H}\big) \right],$$

as the mass λ of shoppers is attracted unless the rival stocks low quality in $i = 1$ and prices below $p_H \frac{q_L}{q_H}$ (joint probability $(1-\alpha^*)F_L\big(p_H \frac{q_L}{q_H}\big)$). Plugging in $F_L(\cdot)$ and simplifying yields

$$\pi_n(p_H; q_H) = [p_H - c_H + (I-1)(q_H - c_H)] \left(\frac{1-\lambda}{2} \right) \left(\frac{I(q_H - c_H)}{p_H \frac{q_L}{q_H} - c_L + (I-1)(q_H - c_H)} \right)$$

for $p_H < \underline{p}_H$. The derivative of $\pi_n(p_H; q_H)$ with respect to p_H has the same sign as

$$q_L c_H - q_H c_L + (I-1)(q_H - c_H)\Delta_q.$$

This is strictly positive for $I > \widehat{I}$, which is true since by assumption $I > \tilde{I}$, and it holds that $\tilde{I} > \widehat{I}$. We have thus shown that it is indeed not profitable to deviate to prices p_H

below $\underline{p}_H$. If instead a retailer stocks q_L in $i = 1$ and chooses a price $p_L \in (\overline{p}_L, q_L]$, its expected gross profit is

$$\pi_n(p_L; q_L) = [p_L - c_L + (I-1)(q_H - c_H)] \left[\frac{1-\lambda}{2} + \lambda \alpha^* \Big(1 - F_H \big(p_L \frac{q_H}{q_L} \big) \Big) \right],$$

as the mass λ of shoppers is only attracted when the rival retailer stocks q_H and chooses a price that exceeds $p_L \frac{q_H}{q_L}$ (joint probability $\alpha^* \big(1 - F_H \big(p_L \frac{q_H}{q_L} \big)\big)$). Inserting $F_H(\cdot)$ and simplifying yields

$$\pi_n(p_L; q_L) = [p_L - c_L + (I-1)(q_H - c_H)] \left(\frac{1-\lambda}{2} \right) \left(\frac{I(q_H - c_H)}{p_L \frac{q_H}{q_L} - c_H + (I-1)(q_H - c_H)} \right)$$

for all $p_L \in (\overline{p}_L, q_L]$. The derivative of $\pi_n(p_L; q_L)$ with respect to p_L now has the same sign as

$$-[q_L c_H - q_H c_L + (I-1)(q_H - c_H)\Delta_q],$$

which is strictly negative as $I > \tilde{I} > \widehat{I}$. Hence, also deviation prices p_L above $\overline{p}_L$ are not profitable. Taken together, we have thus shown that the outlined symmetric strategies indeed constitute an equilibrium, while no equilibrium exists where in $i = 1$ either the high- or the low-quality product is chosen with probability one. We finally note that all CDFs and probabilities used in the construction of the equilibrium are indeed well-behaved as follows: $\alpha^*(\tilde{I}) = 1$ (as is easy to check), so that $\alpha^*(I) \in (0, 1)$, which is also strictly decreasing in I for $I > \tilde{I}$; $F_H(\underline{p}_H) = F_L(\underline{p}_L) = 0$; $F_H(\overline{p}_H) = F_L(\overline{p}_L) = 1$; and $F_H(p_H)$ and $F_L(p_L)$ are strictly increasing in their arguments for $p_H \in [\underline{p}_H, \overline{p}_H]$ and $p_L \in [\underline{p}_L, \overline{p}_L]$, respectively. ■

Q.E.D.