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► **To cite this version:**

| Zhijun Chen, Patrick Rey. Loss Leading as an Exploitative Practice. 2010. hal-00540724

**HAL Id: hal-00540724**

**<https://hal.science/hal-00540724>**

Preprint submitted on 29 Nov 2010

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# LOSS LEADING AS AN EXPLOITATIVE PRACTICE

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*November, 2010*

Cahier n° 2010-29

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# Loss Leading as an Exploitative Practice\*

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November 23, 2010

## Abstract

Large retailers, enjoying substantial market power in some local markets, often compete with smaller retailers who carry a narrower range of products in a more efficient way. We find that these large retailers can exercise their market power by adopting a loss-leading pricing strategy, which consists of pricing below cost some of the products also offered by smaller rivals, and raising the prices on the other products. In this way, the large retailers can better discriminate multi-stop shoppers from one-stop shoppers – and may even earn more profit than in the absence of the more efficient rivals. Loss leading thus appears as an exploitative device, designed to extract additional surplus from multi-stop shoppers, rather than as an exclusionary instrument to foreclose the market, although the small rivals are hurt as a by-product of exploitation. We show further that banning below-cost pricing increases consumer surplus, small rivals' profits, and social welfare. Our insights apply generally to industries where a firm, enjoying substantial market power in one segment, competes with more efficient rivals in other segments, and procuring these products from the same supplier generates customer-specific benefits. They also apply to complementary products, such as platforms and applications. There as well, our analysis provides a rationale for below-cost pricing based on exploitation rather than exclusion.

JEL Classification: L11, L41

Keywords: loss leading, exploitative practice, retail power

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\*We are grateful to Clemence Christin, Paul Dobson, Martin Peitz, Bill Rogerson, Joel Sandonis, Konrad Stahl, and John Vickers for their comments, as well as seminar participants at the University of Amsterdam, the Toulouse School of Economics, Oxford University, the University of Mannheim, the University of Rochester, the University of Michigan, Harvard University, Carleton University, the Office of Fair Trading, UK, the XXV Jornadas de Economía Industrial, EARIE 2010 and the CSIO-IDEI conference at Northwestern University. Zhijun Chen is also grateful for the funding provided by the Marie-Curie Intra-European Fellowship (grant No. IEF-251019).

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# 1 Introduction

The last three decades have seen the emergence of large retailers that offer a full range of groceries and other goods to attract consumers through one-stop shopping, as well as an increased concentration in retail markets. As a result, in many local retail markets there is limited competition among large retailers, who have substantial market power over parts of the product lines<sup>1</sup> and compete mainly with smaller stores, such as hard-discounters and specialist retailers, who carry much narrower product lines but may be more efficient in delivering these goods.<sup>2</sup> This raises a concern that large retailers may impede competition by leveraging their market power into the product segments that are also served by their smaller rivals.<sup>3</sup>

Large grocery retailers are able to exercise their market power in two ways, namely, through *buyer power* against suppliers or *seller power* against consumers and smaller rivals.<sup>4</sup> While most of the recent literature has focused on buyer power,<sup>5</sup> relatively little attention has been

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<sup>1</sup>For instance, in its assessment of local market concentration in grocery retailing, the UK Competition Commission (2008, Section 6) defines *highly-concentrated local markets* as "local markets with three or fewer fascia in total where one of those fascia had a share of local grocery sales area that is greater than 60 per cent within a 10- or 15 minute drive-time." It finds that 27% of larger grocery stores are located in highly-concentrated local markets within a 10-minute drive time. The Commission finds moreover that the impact on a large retailer's profit from another large retailer is less than 4%, and that from small retailers is statistically insignificant; see Competition Commission (2008), Appendix 4.4 at § 47.

<sup>2</sup>The rise of the hard-discount format is a new landscape in grocery-retailing. Hard discounters, popularized in the EU countries by retailers such as Aldi and Lidl, have relatively small sizes and offer much fewer categories of goods – less than 10% of the lines offered by large retailers. Their assortment is dominated by private labels and their shopping environment gives priority to functionality and low distribution costs. As a result, they can offer prices up to 60% lower than those of leading name brands, and 40% lower than large retailers' private labels. See Dobson (2002) and Cleeren *et al.* (2008) for a detailed discussion.

<sup>3</sup>See for example the reports of the US Federal Trade Commission (2001, 2003), the proceedings of the FTC conference held on May 24, 2007, available at <http://www.ftc.gov/be/grocery/index.shtm>, or the groceries market enquiries of the UK Competition Commission (2000, 2008) recommending the adoption of codes of practices. In France, these concerns motivated in 1996 two Acts, aimed at curbing the expansion of large retailers as well as the exploitation of their market power.

<sup>4</sup>See Dobson and Waterson (1999) for a detailed discussion.

<sup>5</sup>For example, Chen (2003) argues that buyer power results in lower prices for both retailers and consumers. While practitioners have often voiced concerns that buyer power might discourage suppliers' investment and innovation – see for example European Commission (1999) at p. 4 –, Inderst and Wey (2007) develop a model in which buyer power may instead increase suppliers' investment and enhance welfare.

devoted to the analysis of seller power and its impact on retail competition.<sup>6</sup> Yet, as argued by Paul Dobson (2009), it is in regard to how large retailers can distort retail competition that we might see the most profound market effects. This paper sheds a new light on the exercise of seller power and shows that it can lead large retailers to adopt a *loss leading* strategy, which consists of pricing below cost some of the competitive products (leader products) and charging higher prices for the other goods. This practice is indeed widely adopted by large retailers: in its groceries market investigation, the UK Competition Commission notes for example that most large retailers in the UK engage in loss leading, mainly for staples such as milk and dairy, alcohol, bread and bakery products that consumers purchase repeatedly and regularly – and which constitute the core product lines of small retailers such as hard-discounters; it finds that the sales of loss leader products represent up to 6% of a retailer’s total sales.<sup>7</sup>

Antitrust enforcement and regulations against loss leading have stirred hot debates. For instance, in 2000 the German Federal Cartel Office ordered Wal-Mart, Aldi, and Lidl to stop selling below cost staples including milk and butter, arguing that this could impair competition and force smaller retailers to exit the market. By contrast, OECD (2007) argues that rules against loss leading are likely to protect inefficient competitors and harm consumers. There are also conflicting judgements on loss leading in US case law. For example, in *American Drugs vs. Wal-Mart Stores* (1993), Wal-Mart was sued under Arkansas’ *Unfair Practice Act* for below-cost pricing on certain pharmaceuticals. Wal-Mart lost the initial trial, but however successfully appealed before the Supreme Court of Arkansas, which ruled that "the loss-leader strategy employed by Conway Wal-Mart is readily justifiable as a tool to foster competition and to gain a competitive edge as opposed to simply being viewed as a stratagem to eliminate rivals

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<sup>6</sup>The recent literature on seller power has mainly focused on its interaction with buyer power through the so-called "waterbed effect". Dobson and Inderst (2007) and Inderst and Valletti (2008) argue for example that large retailers, who possess more bargaining power than their smaller rivals, can obtain better terms when negotiating with suppliers, which in turn may lead suppliers to increase the prices they charge to smaller retailers. While such a waterbed effect could cause a self-perpetuating process widening the gap in the terms obtained by large and small retailers, some of the latter ones, such as hard discounters, belong to large retail networks who have developed their own private labels and business formats designed to reduce their operational costs. This paper studies such asymmetric competition, where large retailers face smaller but more efficient retailers, and ignores the role of buyer power in order to focus specifically on how large retailers can use their seller power at the expense of consumers and smaller rivals.

<sup>7</sup>See Competition Commission (2008); Dobson (2002) also provides a detailed economic analysis of loss-leading pricing in UK grocery retailing, with particular emphasis on bakery retailers.

all together."<sup>8</sup> A similar discrepancy appears in the statutes dealing with below-cost sales.<sup>9</sup> In the US, 22 states are equipped with general sales-below-cost laws, and 16 additional states prohibit below-cost sales on motor fuel. In the EU, below-cost resale is banned in Belgium, France, Ireland, Luxembourg, Portugal, and Spain, and is restricted in other countries including Austria, Denmark, Germany, Greece, Italy, Sweden and Switzerland, whereas it is generally allowed in the Netherlands and the UK.

In the absence of specific regulations, practitioners tend to tackle loss leading with predatory-pricing approaches.<sup>10</sup> However, loss leading is a persistent below-cost pricing strategy, and in most cases courts and competition authorities are unlikely to show the feasibility that the predator could recoup the losses incurred during the predation phase by raising the prices after driving the rival out of the market.<sup>11</sup> For instance, in its 1997 report, the UK Office of Fair Trading argued that, in the analysis of alleged predation in retailing cases, a price-cost comparison is of little use, since pricing below cost on individual items may be profitable without being predatory. This begs several related questions: what is the rationale for loss leading if it is not predatory? What is then the impact on rivals, consumers and society? Competition authorities face a dilemma in answering these questions.<sup>12</sup>

In the economic literature, loss leading has been viewed as an advertising strategy adopted to

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<sup>8</sup>See Boudreaux (1996) for details. Yet in *Star Fuel Marts v. Murphy Oil (2003)*, a preliminary injunction was granted under Oklahoma's Unfair Sales Act, prohibiting below-cost sales of gasoline by Sam's East, a Wal-Mart subsidiary selling groceries in a wholesale club format. The court ruled that pricing below cost was prima facie evidence of intent to harm competitors, as well as of a tendency to dampen competition.

<sup>9</sup>See Skidmore *et al.* (2005). Calvani (2001) also discusses below-cost sales statutes in the U.S.

<sup>10</sup>See e.g., Bolton, Brodley and Riordan (2000) and Eckert and West (2003) for detailed discussions of how predatory-pricing tests should be designed.

<sup>11</sup>The feasibility of recoupment is often a necessary condition for a case of predation; in the U.S., for example, this approach was adopted by the Supreme Court in the *Brooke Group Ltd. v. Brown & Williamson Tobacco Corp.*, which involved allegations of predatory pricing by Brown & Williamson against a smaller rival in an effort to discipline the pricing of generic cigarettes. The Court noted that predatory pricing was generally implausible without recoupment conditions, and further stated that intent ought to play no role in assessing whether conduct is predatory.

<sup>12</sup>For instance, in its most recent report, the UK Competition Commission concludes: "We find that the pattern of below-cost selling that we observed by large grocery retailers does not represent behavior that was predatory in relation to other grocery retailers." (See Competition Commission (2008) at p. 98). However, it also argues that below-cost pricing by large retailers might disproportionately squeeze smaller rivals' profit margins and even force them to exit (See p. 96-97).

attract consumers facing imperfect information of prices;<sup>13</sup> below-cost pricing may then compensate consumers for their imperfect information and thereby improve consumer surplus.<sup>14</sup> Loss leading has also been interpreted as an optimal cross-subsidizing strategy by a multi-product firm facing different demand elasticities across products.<sup>15</sup> By contrast, little attention has been devoted to the often-voiced concerns that small retailers' profits are squeezed by large retailers' loss-leading strategies, and that consumers may end-up facing higher prices for non-staple products.<sup>16</sup>

This paper aims at filling this gap. We develop a model of asymmetric competition between large and small retailers, reflecting the characteristics of concentrated local markets where a few large retailers compete with smaller retailers who carry a narrower product range but in a more efficient way, in terms of higher quality and/or lower cost. We moreover abstract away from the above-mentioned efficiency justifications by assuming that consumers are perfectly informed of all prices and by allowing for homogeneous consumer valuations for the goods. Our key modelling feature is to account for the heterogeneity in consumers' shopping costs: some consumers face higher shopping costs, e.g., because of tighter time constraints or lower taste for shopping, and thus have a stronger preference for one-stop shopping, whereas others have lower shopping costs and can therefore benefit from multi-stop shopping.

We first present the main insights in a stylized setting where a large retailer enjoys a monopoly position over some product lines (the monopolized segment) and faces a competitive fringe of smaller but more efficient rivals on other goods (the competitive segment). For simplicity, in this

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<sup>13</sup>Lal and Matutes (1994), for example, consider a situation where multi-product firms compete for consumers who are initially unaware of prices, and find that in equilibrium firms may indeed choose to advertise a few loss leaders in order to increase store traffic. Ellison (2005) develops the model to analyze add-on pricing, and shows that loss leading can be optimal when firms advertise base goods while add-on prices are unobserved.

<sup>14</sup>Walsh and Whelan (1999) show that, in the presence of imperfect information, loss leading can generate the same long-run equilibrium outcomes as those observed under a *laissez-faire* full information scenario.

<sup>15</sup>Bliss (1988) may be the first paper viewing loss leading as a cross-subsidizing strategy, but does not formally establish existence conditions. Beard and Stern (2008) build on this model and incorporate continuous rather than unit consumer demands; they show that loss leading can indeed arise although for rather specific demand functions. Ambrus and Weinstein (2008) study Bertrand competition among symmetric firms competing for one-stop shoppers. They first show that loss leading cannot occur when consumers have inelastic demand. When demand is elastic, loss leading can occur but only under rather specific forms of demand complementarity; in particular, loss leading cannot arise when consumer demand is sufficiently diverse. The scope for loss leading in these settings, as well as its impact on consumers and welfare, still needs to be assessed.

<sup>16</sup>See, for instance, Dobson (2002), at p.13.

setting all consumers have homogeneous valuations for the goods. If the rivals were excluded from the competitive segment, the large retailer would charge monopoly prices for both segments, based on consumer valuations and the distribution of their shopping costs. When more efficient rivals are present in the competitive segment, however, consumers with low shopping costs engage in multi-stop shopping: they buy the competitive goods from a more efficient rival, who offers better value, while still purchasing the monopolized goods from the large retailer. In contrast, consumers with higher shopping costs, who thus favor one-stop shopping, keep buying both types of products from the large retailer as long as its broader range of products delivers overall a greater value. The presence of more efficient rivals thus exerts a competitive pressure on the large retailer, but at the same time it opens a door for screening multi-stop shoppers from one-stop shoppers. We show that this is optimally achieved by adopting a loss-leading strategy, that is, by pricing the competitive goods below cost and raising instead the price for the monopolized goods, keeping constant the total margin charged to one-stop shoppers; this pricing strategy, which entails a negative margin in the competitive segment, allows the large retailer to earn a higher margin from multi-stop shoppers in the monopolized segment.

We show that loss leading indeed arises whenever the additional value generated by the large retailer's broader lines of products (the monopolized segment) exceeds the rivals' efficiency advantage in the competitive segment. In any such cases, loss leading allows the large retailer to increase its profit, at the expense of consumer surplus, market efficiency and social welfare. When its broader range generates a large enough comparative advantage, the large retailer can even obtain in this way more profit than in the absence of the smaller rivals. We then extend the analysis to the case where the large retailer faces a strategic rival rather than a fringe in the competitive segment, in which case loss leading also hurts the rival by reducing the market share and squeezing the profit margin that the small retailer would otherwise obtain. However, this margin squeeze appears here as a by-product of exploitation rather than driven by exclusionary motives; indeed, it is the very presence of a rival offering better terms on a narrower range of products that allows the large retailer to better screen consumers according to their shopping costs. In other words, loss leading emerges here as an exploitative practice, adopted by the large retailer to extract consumer surplus, rather than as an exclusionary device aimed at foreclosing the market. Yet, the lack of exclusionary intention, as well as the fact that the small retailers remain active, should not lead to the conclusion that loss leading is an innocuous strategy, since its use as an exploitative device hurts consumers as well as rivals.<sup>17</sup> We show that a ban on loss

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<sup>17</sup>In his report prepared on behalf of the Federation of Bakers, Dobson (2002) argues that the structure of



leading would discipline the large retailer and benefit consumers as well as the small rival, and would also increase social welfare by improving the distribution efficiency in the competitive segment.

Finally, we show that loss leading still arises in more general settings with heterogeneous consumer valuations for the goods and/or (imperfect) competition among large retailers (in a symmetric Hotelling fashion). While retail competition among large retailers limits their overall margins, the presence of smaller but more efficient rivals still opens a door for discriminating multi-stop shoppers from one-stop shoppers, and again this is optimally achieved through loss leading. The exploitative use of loss leading thus appears to be a robust feature in market environments where a few large retailers enjoy substantial market power over one-stop shoppers and compete with more efficient rivals carrying narrower lines of products.

To summarize, this paper provides a new rationale for the adoption of loss leading and highlights its harmful impact on retail competition and consumers in the absence of efficiency justifications, thus giving support to small rivals' complaints and competition concerns.<sup>18</sup> The analysis also supports the expressed doubts about the exclusionary motive of the practice, and stresses instead its role as an exploitative device. Yet, this exploitative use of loss leading harms consumers and society as well as the small rivals, which may provide a rationale for antitrust enforcement.<sup>19</sup>

While this research is motivated by the use of loss leading in retail markets, its insights apply to a variety of situations where: (i) a firm enjoys substantial market power in one market and faces tougher competition in other markets; (ii) dealing with a single supplier gives customers some benefits (e.g. due to scale economies, lower adoption or maintenance costs, ...), which vary

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the UK retail market, and the mix of different retail formats, is particularly conducive to the emergence of loss leading, as a form of competitive price discrimination which could lead to higher prices on other products, thus harming consumers as well as squeezing smaller rivals' profits.

<sup>18</sup>Chambolle (2005) also studies asymmetric competition between a large retailer and a smaller one, in a different setting in which both retailers are equally efficient, but a majority of consumers is closer to the smaller store, and travel costs are too large for multi-stop shopping; the large retailer then never uses the competitive good as a loss leader, but can instead use in this way the monopolized good, in which case this can benefit consumers as well as society. This is in line with the observation that in practice, concerns are voiced when loss leaders are chosen among the staples offered by the smaller retailers.

<sup>19</sup>Allain and Chambolle (2005) and Rey and Vergé (2010) note however that below-cost pricing regulations can allow manufacturers to impose price floors on their retailers, in which case they can be used to better exert market power or to reduce interbrand as well as intrabrand competition; banning loss leaders may then have a perverse effect on consumer welfare.

across customers. Pricing below cost in the competitive markets then allows the larger firm to screen customers more effectively and extract part of the benefits. This insight can shed a new light on antitrust cases such as the *IBM* and *Microsoft* cases;<sup>20</sup> while the debates have mainly focused on exclusionary purposes, our analysis suggests an alternative framework of analysis based instead on exploitative motives.

The rest of the paper is organized as follows. Section 2 presents a simple model of asymmetric retail competition between a large retailer and smaller rivals, where consumers only differ in their shopping costs. Section 3 shows that loss leading arises as an exploitative device whenever the large retailer enjoys substantial market power over some product segments and competes in other segments with a fringe of smaller but more efficient retailers; section 4 extends this insight to the case where the large retailer competes instead with a strategic smaller retailer. Section 5 analyzes the welfare impact of a ban on loss leading, while section 6 investigates the robustness of the analysis under more general settings that allow imperfect competition and heterogeneous consumer valuations, and discusses applications to a variety of situations. Finally, section 7 concludes.

## 2 The model

### 2.1 Market structure and consumer choice

A large retailer (denoted by  $L$ ), who supplies a broad range of products, competes in a local market with one or several homogeneous small retailers (denoted by  $S$ ) who offer much narrower product lines. For the sake of exposition, we simply assume that there are two markets (which can be interpreted as different goods or different lines of products),  $A$  and  $B$ . Product  $A$  is monopolized by  $L$ , while different varieties of product  $B$ , denoted by  $B_L$  and  $B_S$ , are offered by  $L$  and  $S$ ; in what follows, we will refer to  $A$  as the "monopolized segment" and to  $B$  as the "competitive segment".  $L$  incurs respectively a unit cost  $c_A$  and  $c_L$  for supplying  $A$  and  $B_L$ , while  $S$  faces a unit cost  $c_S$  for  $B_S$ .

Each consumer desires at most one unit of  $A$  and one unit of  $B$ ;<sup>21</sup> consuming  $A$  or  $B_i$  (for

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<sup>20</sup>See e.g. *United States v. International Business Machines Corporation*, Docket number 69 Civ. DNE (S.D. NY) and *United States of America v. Microsoft Corporation*, Civil Action No. 98-1232 TPJ (D.C.).

<sup>21</sup>The assumption of unit demands appears reasonable for groceries and other day-to-day consumer purchases. To be sure, price changes affect the composition of consumer baskets, but are less likely to have a large impact on the volume of purchases for staples.

$i = L, S$ ) brings a utility  $u_A$  or  $u_i$ , while consuming both  $A$  and  $B_i$  yields  $u_{Ai} \leq u_A + u_i$ .<sup>22</sup> Assuming homogeneous valuations for  $A$ ,  $B_L$  and  $B_S$  allows us to avoid cross-subsidization motives stemming from differences in demand elasticities, as studied by Bliss (1988).<sup>23</sup> For the analysis, it is convenient to use the social values  $w_i \equiv u_i - c_i$  (for  $i = A, L, S$ ) and  $w_{Ai} \equiv u_{Ai} - c_A - c_i$  (for  $i = L, S$ ). We are interested in the case where it is socially efficient for  $L$  to supply both products rather than one:  $w_{AL} > w_A, w_L$ ;<sup>24</sup> in particular, its broader range of products enables  $L$  to bring an additional value  $w_{AL} - w_L > 0$ . We are moreover interested in the case where small retailers are more efficient in distributing  $B$ :<sup>25</sup>  $w_S > w_L$ . For the sake of exposition, we assume that the efficiency advantage of small retailers does not affect the added value of  $A$ :  $w_{AS} - w_S = w_{AL} - w_L$ .

Finally, we build on Armstrong and Vickers (2010) and assume that consumers incur a shopping cost for visiting a store.<sup>26</sup> This shopping cost may reflect the opportunity cost of the time spent in traffic, parking, selecting products, checking out, and so forth; it may also account for the consumer's taste for shopping. To highlight the fact that consumers may be more or less time-constrained, or value their shopping experience in different ways, we assume that the shopping cost, denoted by  $t$ , varies across consumers and is distributed according to a cumulative distribution function  $F(\cdot)$ , with density function  $f(\cdot)$ ; we assume that the inverse hazard rate,  $h(\cdot) \equiv F(\cdot)/f(\cdot)$ , is strictly increasing.<sup>27</sup>

We model retail competition as follows: (i)  $L$  and  $S$  simultaneously set their prices, respectively  $(p_A, p_L)$  and  $p_S$ ;<sup>28</sup> (ii) consumers then observe all prices and make their shopping decisions. When making these decisions, consumers are thus fully aware of all prices and take

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<sup>22</sup>This allows for (partial) substitution between  $A$  and  $B$ ; the analysis however readily applies to the case of complementary goods – see section 7.2.

<sup>23</sup>To show the robustness of the analysis, we relax this assumption in section 6.

<sup>24</sup>These conditions imply  $c_A < u_{AL} - u_L \leq u_A$  and  $c_L < u_{AL} - u_A \leq u_L$ . It is thus indeed *a fortiori* efficient for  $L$  to supply either product rather than none:  $w_A, w_L > 0$ .

<sup>25</sup>For instance, small retailers could be discount stores with lower distribution costs, or specialist stores that bring higher value for  $B$ .

<sup>26</sup>Armstrong and Vickers (2010) consider a symmetric duopoly à la Hotelling in which consumers have heterogeneous and elastic demands for two products and incur an additional shopping cost when dealing with both suppliers; they show the existence of an equilibrium in which firms price all products above (or at) cost but offer conditional discounts (mixed bundling).

<sup>27</sup>This assumption ensures that profit functions are single-peaked.

<sup>28</sup>We first consider stand-alone prices, and show later that allowing for bundled discounts cannot increase  $L$ 's profit; see the remark in section 3.

also into account the value of the proposed assortments as well as their shopping costs.

We will successively consider several scenarios. In a first scenario,  $B_S$  is competitively supplied by a fringe of small retailers, who offer it at cost; this scenario allows us to develop our main insight in the simplest way, by focusing on  $L$ 's strategy. In a second scenario, a single small retailer acts instead as a strategic player. Studying the (pure strategy) equilibria of this scenario allows us to show the robustness of the main insight and to discuss margin squeeze issues. Finally, we extend the analysis to (imperfectly) competitive large retailers (and heterogeneous valuations for the goods). Before considering these scenarios, we conclude this section with a benchmark case in which  $L$  faces no competition from any rival.

## 2.2 Benchmark: monopoly

We suppose here that  $L$  is a monopolist for both products. By assumption, it is more profitable to sell both products rather than one.<sup>29</sup> Purchasing both products yields a net surplus  $u_{AL} - p_A - p_L - t$ . Consumers will therefore buy as long as  $t \leq v_{AL} \equiv u_{AL} - p_A - p_L = w_{AL} - r_{AL}$ , where  $v_{AL}$  denotes the consumer value from purchasing both  $A$  and  $B_L$ , while  $r_{AL} \equiv p_A - c_A + p_L - c_L$  denotes  $L$ 's total margin. The monopolist thus faces a demand  $F(v_{AL})$  and makes a profit

$$r_{AL}F(v_{AL}) = r_{AL}F(w_{AL} - r_{AL}).$$

This profit function is quasi-concave in  $r_{AL}$  (see Appendix A), and the first-order condition is given by:

$$r_{AL} = h(v_{AL}). \quad (1)$$

The monopoly outcome is thus characterized by  $r_{AL}^m = w_{AL} - v_{AL}^m$  and

$$v_{AL}^m \equiv l^{-1}(w_{AL}), \quad (2)$$

where the function  $l(x) \equiv x + h(x)$  is increasing in  $x$ .  $L$ 's monopoly profit is then given by:<sup>30</sup>

$$\Pi_{AL}^m \equiv F(v_{AL}^m)h(v_{AL}^m). \quad (3)$$

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<sup>29</sup>Since consumers have homogeneous valuations, all active consumers behave in the same way. Suppose that they buy  $B$  only (that is,  $p_A \geq u_{AL} - u_L$ ); then reducing  $p_A$  slightly below  $u_{AL} - u_L$  would ensure that consumers buy  $A$  as well, bringing an additional profit (almost) equal to  $w_{AL} - w_L$  from each of them; a similar reasoning applies to the case where active consumers would only buy  $A$ .

<sup>30</sup>We implicitly assume away here any relevant upper bound on shopping costs. If  $t$  is instead distributed over a range  $[0, T]$ , where  $T \leq l^{-1}(w_{AL})$ , then the optimal (monopoly) value is  $v_{AL}^m = T$  and the corresponding profit is  $(w_{AL} - T)F(T)$ .

### 3 Loss leading as an exploitative device

We suppose in this section that a competitive fringe of small retailers supplies  $B_S$  at cost:  $p_S = c_S$ . One-stop shoppers can thus obtain  $w_S$  by patronizing a small retailer, or  $v_{AL} = w_{AL} - r_{AL}$  by buying both products from  $L$ .

If one-stop shoppers favor  $L$  ( $v_{AL} \geq w_S$ ), which we will refer to as "regime  $L$ ", small retailers can only attract multi-stop shoppers, who buy  $A$  from  $L$  and  $B_S$  from them. Multi-stop shopping involves double shopping costs,  $2t$ , but yields a value  $v_{AS} \equiv u_{AS} - p_A - p_S$ , and consumers are willing to do so if  $v_{AS} - 2t \geq v_{AL} - t$ , that is, if the additional shopping cost is offset by the extra gain from multi-stop shopping (denoted by  $\tau$ ), i.e.,

$$t \leq \tau \equiv v_{AS} - v_{AL} = w_S - w_L + r_L,$$

where  $r_L \equiv p_L - c_L$  denotes  $L$ 's margin on  $B_L$ .

Thus, in regime  $L$  consumers are willing to visit  $L$  as long as  $t \leq v_{AL}$ , while they prefer patronizing both stores if  $t \leq \tau$ .  $L$  therefore attracts a demand  $F(v_{AL}) - F(\tau)$  for both products (from one-stop shoppers) and an additional demand  $F(\tau)$  for product  $A$  only (from multi-stop shoppers);<sup>31</sup> it thus obtains a profit equal to:

$$r_{AL}(F(v_{AL}) - F(\tau)) + r_A F(\tau) = r_{AL}F(v_{AL}) - r_L F(\tau),$$

where  $r_A \equiv p_A - c_A = r_{AL} - r_L$  denotes  $L$ 's margin on  $A$ . Using  $v_{AL} = w_{AL} - r_{AL}$  and  $\tau = w_S - w_L + r_L$ ,  $L$ 's profit can be further expressed as a function of  $r_{AL}$  and  $r_L$  as:

$$\Pi_L(r_{AL}, r_L) = r_{AL}F(w_{AL} - r_{AL}) - r_L F(w_S - w_L + r_L), \quad (4)$$

where  $\Pi_L(r_{AL}, r_L)$  is additively separable and moreover quasi-concave in  $r_{AL}$  and  $r_L$  (see Appendix A). To attract one-stop shoppers,  $L$  must however offer a better value than its rival:<sup>32</sup>  $v_{AL} \geq w_S$ , or

$$r_{AL} \leq w_{AL} - w_S. \quad (5)$$

We now solve for the optimal margins  $r_{AL}$  and  $r_L$ , which maximize (4) subject to the constraint (5). From the expression (4), it is clearly optimal for  $L$  to price  $B_L$  below cost:

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<sup>31</sup>In Appendix B, it is shown that any pricing strategy leading to  $\tau < 0$  (resp.,  $\tau > v_{AL}$ ) is equivalent to a pricing strategy yielding  $\tau = 0$  (resp.,  $\tau = v_{AL}$ ); therefore, without loss of generality, we can restrict attention to prices such that  $\tau \in [0, v_{AL}]$ .

<sup>32</sup>This condition also ensures that prospective multi-stop shoppers are indeed willing to buy  $A$  on a stand-alone basis:  $w_S \leq v_{AL} = w_{AL} - r_A - r_L$  implies  $r_A \leq w_{AL} - w_S - r_L = w_{AL} - w_L - \tau < w_{AL} - w_L = w_{AS} - w_S$ .

the second term  $-r_L F(w_S - w_L + r_L)$  is positive if and only if  $r_L < 0$ .<sup>33</sup> The intuition is straightforward. Keeping  $r_{AL}$  – and thus the total price for one-stop shoppers – constant, subsidizing  $B_L$  allows  $L$  to increase its margin on  $A$  ( $r_A > r_{AL}$ ) and reap in this way a higher profit from multi-stop shoppers, who buy only  $A$  from it. Since the margin  $r_L$  does not affect (5), its optimum is then characterized by the first-order condition:

$$r_L^* = -h(w_S - w_L + r_L^*) = -h(\tau^*) < 0. \quad (6)$$

Using  $r_L^* = \tau^* - (w_S - w_L)$ , the optimal threshold  $\tau^*$  is given by:

$$\tau^* \equiv l^{-1}(w_S - w_L) > 0. \quad (7)$$

Therefore, in regime  $L$  the large retailer obtains a profit equal to:

$$\Pi_L = r_{AL} F(v_{AL}) + h(\tau^*) F(\tau^*),$$

where the first term represents the base profit achieved from both types of customers, whereas the second term represents the additional profit that is extracted from multi-stop shoppers through loss leading.

In the absence of any restriction on its total margin,  $L$  would charge  $r_{AL} = r_{AL}^m$  and offer one-stop shoppers a value  $v_{AL} = v_{AL}^m = l^{-1}(w_{AL})$ . Conversely, this strategy satisfies (5) and thus attracts one-stop shoppers as long as  $v_{AL}^m \geq w_S$ , or  $w_{AL} \geq l(w_S)$  ( $> w_S$ ); therefore, when  $L$  derives a sufficiently large comparative advantage from its broader line of products, the optimal strategy consists of charging the monopoly margin  $r_{AL}^m$  for the bundle, and  $r_L^* = -h(\tau^*)$  for  $B_L$ .<sup>34</sup> The loss-leading strategy then gives  $L$  a profit equal to:

$$\Pi_L^* = r_{AL}^m F(v_{AL}^m) - r_L^* F(\tau^*) = \Pi_{AL}^m + h(\tau^*) F(\tau^*),$$

which *exceeds* the monopolistic profit  $\Pi_{AL}^m$ .

When instead  $L$ 's comparative advantage is not large enough (namely,  $w_{AL} < l(w_S)$ ),  $L$  must improve its offer in order to keep attracting one-stop shoppers. It is then optimal for  $L$

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<sup>33</sup>More precisely, any  $r_L > 0$  is dominated by  $r_L = 0$ , which in turn is dominated by any slightly negative  $r_L$ ; pricing way below cost (namely,  $r_L < -(w_S - w_L)$ ) would however eliminate multi-stop shopping ( $\tau < 0$ ) and thus yield the same profit as  $r_L = 0$ .

<sup>34</sup>Note that  $\tau^*$  then satisfies  $\tau^* < v_{AL}^m$ . To see this, take instead  $v_{AL}$  and  $\tau$  as control variables and rewrite  $L$ 's profit as  $\Pi_L(v_{AL}, \tau) = r_{AL} F(v_{AL}) - r_L F(\tau) = (w_{AL} - v_{AL}) F(v_{AL}) + (w_S - w_L - \tau) F(\tau)$ . Then we have  $v_{AL}^m = \arg \max_v (w_{AL} - v) F(v) > \arg \max_v (w_S - w_L - v) F(v) = \tau^*$ , since  $w_{AL} \geq l(w_S)$  ( $> w_S \geq w_S - w_L$ ).

to match the value offered by the competitive fringe:  $\tilde{v}_{AL}^* = w_S$ , or  $\tilde{r}_{AL}^* = w_{AL} - w_S (< r_{AL}^m)$ .<sup>35</sup> The loss-leading strategy then gives  $L$  a profit equal to:

$$\tilde{\Pi}_L^* \equiv (w_{AL} - w_S) F(w_S) + h(\tau^*) F(\tau^*).$$

Alternatively,  $L$  can leave one-stop shoppers to the small retailers ("regime  $S$ ") and focus instead on multi-stop shoppers, who are willing to buy  $A$  from  $L$  as long as the added value  $v_A \equiv w_{AL} - w_L - r_A$  exceeds the extra shopping cost  $t$ . In this way,  $L$  obtains:

$$\Pi_L = r_A F(v_A) = r_A F(w_{AL} - w_L - r_A).$$

It is then optimal for  $L$  to adopt the monopoly margin  $r_A^m$  which, together with the corresponding value  $v_A^m = w_{AL} - w_L - r_A^m$ , are characterized by:

$$r_A^m = h(v_A^m), \quad v_A^m = l^{-1}(w_{AL} - w_L).$$

$L$ 's profit in regime  $S$  is then given by:

$$\Pi_A^m \equiv r_A^m F(v_A^m).$$

The loss-leading strategy is clearly preferable when  $v_{AL}^m \geq w_S$ , since it then gives  $L$  more profit than the monopolistic level  $\Pi_{AL}^m$  (and the latter is greater than  $\Pi_A^m$ ).<sup>36</sup> We show in Appendix B that it remains preferable as long as  $L$  enjoys a comparative advantage over  $S$  (that is,  $w_{AL} \geq w_S$ ), which leads to:

**Proposition 1** *Suppose the large retailer ( $L$ ) faces a competitive fringe of small retailers ( $S$ ). Then:*

- *When  $L$  enjoys a comparative advantage over  $S$  (i.e.,  $w_{AL} > w_S$ ), its unique optimal pricing strategy involves loss leading:  $L$  prices the competitive product  $B_L$  below cost. Furthermore, when its comparative advantage is large (namely,  $v_{AL}^m \geq w_S$ ),  $L$  keeps the total margin for the two products at the monopoly level ( $r_{AL} = r_{AL}^m$ ) and earns a higher profit than in the absence of any rivals; otherwise  $L$  simply obtains a total margin reflecting its comparative advantage ( $r_{AL} = w_{AL} - w_S$ ).*

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<sup>35</sup>If needed,  $L$  can slightly enhance its offer to make sure that it attracts all one-stop shoppers.

<sup>36</sup>For the sake of exposition, throughout the paper we refer to loss leading as *selling* a product below cost. Here, for instance,  $L$  may keep *offering*  $B$  below cost when  $w_{AL} < w_S$ , but it then only sells  $A$  (to multi-stop shoppers, who buys  $B$  from  $S$ ).

- When instead  $L$  faces a comparative disadvantage (i.e.,  $w_{AL} < w_S$ ), its unique optimal pricing strategy consists of monopolizing the non-competitive product and leaving the market of the competitive product to the small retailers.

**Proof.** See Appendix B. ■

Whenever  $L$  can attract one-stop shoppers as well as multi-stop shoppers, loss leading provides an exploitative device, which allows  $L$  to discriminate more effectively these two categories of consumers: keeping the total margin constant to attract one-stop shoppers, using  $B_L$  as a loss leader allows  $L$  to raise the price for  $A$  and earn higher profit from multi-stop shoppers. As long as  $w_S \leq v_{AL}^m$ ,  $L$  can keep the total price at the monopoly level and earns in this way more profit than in the absence of any rival. In this range, an increase in  $w_S$  actually benefits  $L$ , who can exploit the efficiency gain of its rivals ( $h(\tau^*)F(\tau^*)$  increases with  $w_S$ ); however, it also mitigates  $L$ 's comparative advantage and reduces the parameter region in which  $L$  can benefit from loss leading. When instead  $v_{AL}^m < w_S \leq w_{AL}$ , an increase in  $w_S$  forces  $L$  to reduce its total margin ( $r_{AL} = w_{AL} - w_S$  decreases). Finally, when  $w_S > w_{AL}$ ,  $L$  loses its comparative advantage and can only monopolize market  $A$ .

*Remark: Bundled discounts.* In principle,  $L$  might offer three prices: one for  $A$ , one for  $B_L$  and one for the bundle. But, since  $L$  sells  $A$  to every consumer who visits its store, only two prices matter here: the price  $p_A$  when buying  $A$  only, and the total price  $p_{AL}$  when buying both  $A$  and  $B_L$ . Alternatively, these prices can be implemented through stand-alone prices,  $p_A$  for  $A$  and  $p_L \equiv p_{AL} - p_A$  for  $B_L$ . Therefore, offering an additional bundled discount based on two stand-alone prices  $p_A$  and  $p_L$  could not improve  $L$ 's profit here.

*Illustration: Uniform density of shopping costs.* Suppose that the shopping cost is uniformly distributed:  $F(t) = t$ . The optimal  $r_L$  and optimal threshold  $\tau$  are then given by:

$$r_L^* = -\tau^*, \tau^* = \frac{w_S - w_L}{2}.$$

Then, whenever  $w_{AL} \geq 2w_S$ , the optimal margin  $r_{AL}$  is set to the monopoly level

$$r_{AL}^m = v_{AL}^m = \frac{w_{AL}}{2},$$

and in this way  $L$  obtains more profit than the monopoly level:

$$\Pi_L^* = \Pi_{AL}^m + \frac{(w_S - w_L)^2}{4} = \frac{(w_{AL})^2}{4} + \frac{(w_S - w_L)^2}{4}.$$

When instead  $w_S \leq w_{AL} < 2w_S$ ,  $L$  maintains the same margin  $r_L^*$  but charges  $\tilde{r}_{AL}^* = w_{AL} - w_S$ , and its profit reduces to:

$$\tilde{\Pi}_L^* = (w_{AL} - w_S)w_S + \frac{(w_S - w_L)^2}{4},$$



which coincides with

$$\Pi_A^m = \frac{(w_{AL} - w_L)^2}{4}$$

when  $w_{AL} = w_S$ . Finally, whenever  $w_{AL} < w_S$ ,  $L$  leaves the competitive segment to its smaller rivals and earns  $\Pi_A^m$  by exploiting its monopoly power on  $A$ .

*Remark: asymmetric shopping costs.* In practice, a consumer may incur different costs when visiting  $L$  or  $S$  – visiting a larger store may for example be more time-consuming. Our analysis easily extends to such situations. Suppose for example that consumers bear a cost  $\alpha t$  when patronizing  $L$  (and  $t$ , as before, when visiting  $S$ ). The threshold  $\tau$  remains unchanged,<sup>37</sup> while one-stop shoppers are now willing to patronize  $L$  as long as  $t < v_{AL}/\alpha$ . As long as  $L$  attracts one-stop shoppers, its profit is now:

$$\Pi_L = r_{AL} \left( F \left( \frac{v_{AL}}{\alpha} \right) - F(\tau) \right) + r_A F(\tau) = r_{AL} F \left( \frac{v_{AL}}{\alpha} \right) - r_L F(\tau),$$

which leads  $L$  to adopt the same loss-leading strategy as before  $r_L^* = -h(\tau^*)$ , where  $\tau^* = l^{-1}(w_{AS} - w_{AL})$ .

## 4 Loss leading and margin squeeze

Focusing on the case where the small retailer is a competitive fringe allows us to highlight the pure exploitative effect of loss leading without considering its impact on the smaller rivals, since competition among them dissipate their margins anyway. Yet, in many antitrust cases, small retailers have complained that their profits were squeezed as a result of large retailers' loss-leading strategies. We thus consider here the case where  $L$  competes against a single smaller rival  $S$ ; this allows us to analyze the margin-squeeze effect on  $S$  caused by loss leading.

$S$  now earns a positive margin  $r_S > 0$  from the product  $B_S$  and leaves a value  $v_S = w_S - r_S$  for the consumers. The previous analysis of  $L$ 's pricing behavior still applies here, except for replacing the competitive value  $w_S$  with the net value  $v_S = w_S - r_S$ . We will focus here on the regime where  $L$  attracts one-stop shoppers by offering a better value than its rival ( $v_{AL} > v_S$ ).  $L$  then faces a demand  $F(v_{AL}) - F(\hat{\tau})$  on both products from one-stop shoppers, and an additional demand  $F(\hat{\tau})$  on product  $A$  from multi-stop shoppers, where the shopping cost threshold is given by:

$$\hat{\tau} \equiv v_{AS} - v_{AL} = w_S - w_L + r_L - r_S. \quad (8)$$

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<sup>37</sup>A consumer favors multi-stop shopping if  $v_{AS} - (1 + \alpha)t > v_{AL} - \alpha t$ , which amounts as before to  $t < \tau = v_{AS} - v_{AL}$ .

In this way,  $L$  earns a profit:

$$\begin{aligned}\Pi_L &= r_{AL}F(v_{AL}) - r_L F(\hat{\tau}) \\ &= r_{AL}F(w_{AL} - r_{AL}) - r_L F(w_S - w_L + r_L - r_S).\end{aligned}\tag{9}$$

The optimal margins are then determined implicitly by the first-order conditions

$$r_{AL} = h(v_{AL}) \text{ and } r_L = -h(\hat{\tau}).$$

Since  $S$  only attracts multi-stop shoppers, it obtains a profit

$$\Pi_S = r_S F(\hat{\tau}) = r_S F(w_S - w_L + r_L - r_S).\tag{10}$$

Therefore, its best response to  $r_L$  is given by the first-order condition:

$$r_S = h(\hat{\tau}).$$

These first-order conditions form a candidate equilibrium in which  $L$ : (i) earns the monopoly margin for the bundle of products ( $\hat{r}_{AL}^* = r_{AL}^m$ ), and (ii) prices the competitive good below cost ( $\hat{r}_L^* = -\hat{r}_S^* = -h(\hat{\tau}^*)$ ). The equilibrium margin  $\hat{r}_L^*$  and  $\hat{r}_S^*$  and the resulting threshold  $\hat{\tau}^*$  thus satisfy:

$$\hat{\tau}^* = w_S - w_L + \hat{r}_L^* - \hat{r}_S^* = w_S - w_L - 2h(\hat{\tau}^*),$$

which yields

$$\hat{\tau}^* \equiv j^{-1}(w_S - w_L),\tag{11}$$

where  $j(x) \equiv x + 2h(x)$  is strictly increasing. In this candidate equilibrium,  $S$  earns a profit

$$\hat{\Pi}_S^* \equiv h(\hat{\tau}^*) F(\hat{\tau}^*),$$

while  $L$  obtains

$$\hat{\Pi}_L^* \equiv \Pi_{AL}^m + h(\hat{\tau}^*) F(\hat{\tau}^*).$$

Since  $\hat{\tau}^* = j^{-1}(w_S - w_L) < l^{-1}(w_S - w_L) = \tau^*$ ,  $L$ 's profit is lower than in the previous case, where it was facing a competitive fringe of small retailers.

For the above margins to form an equilibrium, two conditions must be satisfied: first,  $L$  must indeed attract one-stop shoppers; second, while  $L$  has no incentive to exclude its rival, since it earns more profit than a pure monopolist,  $S$  may want to attract one-stop shoppers by offering a higher value than  $v_{AL}^m$ . We show in Appendix C that these two conditions are satisfied when  $L$  enjoys a significant comparative advantage, namely, when  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ , where the threshold  $\hat{w}_{AL}(w_S, w_L)$  lies above  $w_S$  and increases with  $w_S$ . We also show that loss leading does not arise when  $w_{AL} < \hat{w}_{AL}(w_S, w_L)$ :

**Proposition 2** *Suppose that the large retailer,  $L$ , faces a strategic smaller rival,  $S$ . Then loss leading arises in a unique Nash equilibrium if and only if  $L$  enjoys a significant comparative advantage (namely,  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ ). In that equilibrium,  $L$  sells the competitive product below-cost while keeping the total price for both products at the monopoly level, and it earns a profit higher than that absent the rival.*

**Proof.** See Appendix C. ■

Loss leading thus constitutes a robust exploitative device, which allows  $L$  to discriminate multi-stop shoppers from one-stop shoppers even when competing with a strategic smaller rival. As before, adopting loss leading allows  $L$  to earn even more profit than a pure monopolist if its comparative advantage is large enough. Compared with the case of a competitive fringe, loss leading is now adopted in equilibrium only when it allows  $L$  to earn the full monopoly margin from one-stop shoppers, but it does so in a broader range of circumstances: it is shown in Appendix C that the equilibrium condition  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$  is less stringent than the similar condition for the case of a competitive fringe ( $v_{AL}^m \geq w_S$ ).

Compared with the case of a competitive fringe of smaller retailers, whose profit is not affected by  $L$ 's behavior, the loss-leading strategy now reduces  $S$ 's profit, not only by decreasing its market share, but also by squeezing its margin:  $S$ 's best response is  $r_S = h(\hat{\tau})$ , where  $\hat{\tau} = l^{-1}(w_S - w_L + r_L)$  decreases with  $r_L$ . Yet, this appears here as a side effect of the exploitative motive rather than as the result of exclusionary motive. In particular, foreclosing the market through strategic tying or (pure) bundling would not be profitable here, since  $L$  could obtain at most the monopoly profit in the case of exclusion.

*Remark: Strategic margin squeeze.* Although margin squeeze appears here as a by-product of the use of loss leading as an exploitative device, the large retailer has an incentive to manipulate its rivals' prices: the lower  $S$ 's price for  $B_S$ , the more  $L$  can extract from multi-stop shoppers. As a result, and in contrast to the standard case where firms usually benefit from higher rival prices, here  $L$  wants  $S$  to *decrease* its own price. Thus, if  $L$  could move first and act as a Stackelberg leader, it would *decrease* even further its price for  $B_L$  (in contrast with the standard Stackelberg insight), so as to force  $S$  to respond by decreasing its own price, and in this way allow  $L$  to raise its price on  $A$  for multi-stop shoppers.

Since  $L$  benefits from the presence of  $S$ , it may however want to limit its loss-leading strategy in order to maintain that presence. Suppose for example that the entry of  $S$  is uncertain. It is then profitable for  $L$  to adopt a loss-leading strategy in case of entry, in order to extract additional rents from multi-stop shoppers, but this also reduces the likelihood of entry. Thus, while  $L$  could

not gain from committing itself to never adopting a loss-leading strategy (since then it would extract no additional rent from multi-stop shoppers), it would benefit from limiting its extent. We develop a simple model along this line in Appendix D, which yields the following insights:

**Proposition 3** *If  $L$  and  $S$  compete as Stackelberg leader and follower, then whenever  $L$ 's comparative advantage leads it to adopt a loss-leading strategy, it sells the competitive product  $B$  further below-cost, compared with what it would do in the absence of a first-mover advantage. However, if the entry of  $S$  depends on the realization of a random entry cost, then when  $L$ 's comparative advantage leads it to adopt a loss-leading strategy, it limits the subsidy on  $B$  so as to increase the likelihood of entry.*

**Proof.** See Appendix D. ■

## 5 Banning loss leading

We now show that loss leading reduces consumer surplus and social welfare as well as smaller rivals. For the sake of exposition, we consider here the scenario where  $L$  faces a strategic rival, and focus moreover on the regime in which  $L$  attracts one-stop shoppers and thus engages in loss leading (that is,  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ ).

Suppose  $L$  is not allowed to price below cost. We show in Appendix E that  $L$  then keeps attracting one-stop shoppers in equilibrium. Since the profit expression (9) is quasi-concave and separable in  $r_{AL}$  and  $r_L$ ,  $L$  maintains the total margin at the monopoly level ( $r_{AL}^m$ ) but now sells  $B_L$  at cost ( $r_L = 0$ ); consequently, its profit is reduced to  $\Pi_{AL}^m = r_{AL}^m F(v_{AL}^m)$ .

Since  $L$  no longer subsidizes the competitive segment,  $S$  faces more demand from multi-stop shoppers: the shopping cost threshold increases from  $\tau = w_S - w_L + r_L^* - r_S$  to  $\tau = w_S - w_L - r_S$ . Maximizing its profit  $\Pi_S = r_S F(\tau)$  then leads  $S$  to charge a margin satisfying  $r_S = h(\tau) = h(w_S - w_L - r_S)$ , and the equilibrium threshold becomes:

$$\tau^* = l^{-1}(w_S - w_L) > j^{-1}(w_S - w_L) = \hat{\tau}^*.$$

That is,  $S$  increases its market share (from  $\hat{\tau}^*$  to  $\tau^*$ ) and its margin (from  $\hat{r}_S^* = h(\hat{\tau}^*)$  to  $\hat{r}_S^b \equiv h(\tau^*)$ ) and, consequently, increases its profit by

$$\Delta_{\Pi_S} = h(\tau^*) F(\tau^*) - h(\hat{\tau}^*) F(\hat{\tau}^*) > 0.$$

Banning loss leading does not affect the value of one-stop shopping, since  $L$  maintains the same total margin,  $r_{AL}^m$ . It however encourages consumers to take advantage of multi-stop shopping: banning loss leading forces  $L$  to compete "on the merits", which induces those consumers

with a shopping cost lower than  $\tau^*$  to patronize both stores; in contrast, subsidizing  $B_L$  (and overcharging  $A$  by the same amount) discourages consumers with a shopping cost exceeding  $\hat{\tau}^*$  from visiting  $S$ . The ban on loss leading thus benefits consumers whose shopping cost lies between  $\hat{\tau}^*$  and  $\tau^*$ , since the resulting lower price for  $A$  allows them to save  $\tau^* - t$ . Using a revealed preference argument, it also benefits genuine multi-stop shoppers (those with a shopping cost  $t < \hat{\tau}^*$ ), by increasing the value of multi-stop shopping from  $\hat{v}_{AS}^* \equiv v_{AL}^m + \hat{\tau}^*$  to  $v_{AS}^* \equiv v_{AL}^m + \tau^*$ . Overall, a ban on loss leading thus increases total consumer surplus by:

$$\Delta_{CS} = (\tau^* - \hat{\tau}^*) F(\hat{\tau}^*) + \int_{\hat{\tau}^*}^{\tau^*} (\tau^* - t) dF(t) > 0.$$

Finally, the increase in multi-stop shopping activity also enhances efficiency, since more consumers benefit from a better distribution of  $B$ . The gain in social welfare is equal to:

$$\Delta_W = \int_{\hat{\tau}^*}^{\tau^*} (w_S - w_L - t) dF(t),$$

and is positive since  $\hat{\tau}^* < \tau^* < w_S - w_L$ . Therefore, we have:

**Proposition 4** *Assume that  $L$  faces a strategic rival and would engage in loss leading. Banning below-cost pricing then leads to an equilibrium where  $L$  maintains the same total margin but sells the competitive good at cost; as a result, the ban increases consumer surplus, the rival's profit, and social welfare.*

**Proof.** See Appendix E. ■

A similar analysis applies when  $L$  faces a competitive fringe. While loss leading no longer affects rivals' profit, it still reduces their market share and thus distorts distribution efficiency at the expense of consumers. Banning loss leading thus improves again consumer surplus and social welfare.

As noted in the introduction, competition authorities have been reluctant to treat loss leading as predatory pricing, and some countries have instead adopted below-cost pricing regulations. By showing that loss leading can be used as an exploitative device, to extract extra rents from multi-stop shoppers, rather than as an exclusionary or predatory practice, our analysis sheds a new light on the rationale of loss leading and can help placing the assessment of its anticompetitive effects on firmer ground.

## 6 Extensions: heterogeneous valuations and competition among large retailers

The use of loss leading as an exploitative device, which aims at extracting additional surplus from multi-stop shoppers, has been so far established in a relatively simple setting where a large retailer enjoys local monopoly power on some product segments and consumers have moreover homogeneous valuations in all segments. We now investigate the robustness of our insights in more general situations.

Note first that introducing heterogeneous valuations for  $B$  does not affect our analysis of loss leading as long as consuming  $B_L$  remains efficient (that is,  $u_L > c_L$  for all consumers): since  $L$  prices  $B_L$  below cost in equilibrium, the consumer value from  $B_L$  is always positive ( $v_L = u_L - p_L > 0$ ), and so is the value from  $B_S$  as  $v_S > v_L$ ; therefore, one-stop shoppers would still buy  $B_L$  from  $L$  and likewise multi-stop shoppers would buy  $B_S$  from  $S$ . By contrast, heterogeneous valuations for  $A$  make its demand elastic, which limits  $L$ 's ability to raise prices in this segment; this may make loss leading less attractive, since the purpose of the exploitative device is precisely to earn more from multi-stop shoppers on this segment. Likewise, (imperfect) competition among large retailers curbs their capacity to charge high prices on  $A$  and may also discourage the use of loss leading as an exploitative device.

To check the robustness further, we extend here the basic setting to allow for an elastic demand for  $A$  and also for (imperfect) competition among large retailers.

### 6.1 Heterogeneous valuations

We assume here that consumers vary in their valuations of product  $A$ : specifically, a consumer with preference  $x$  obtains a utility  $u_A - \frac{x}{\sigma} - p_A = w_A - r_A - \frac{x}{\sigma}$ . The situation is thus the same as in our basic framework, except that  $L$  now faces an elastic demand for  $A$ ; the parameter  $\sigma$  reflects this elasticity: the higher  $\sigma$ , the faster consumers drop in case of a price increase. The parameter  $x$  can be interpreted as the "distance" between the consumer's ideal variety and that proposed by  $L$ , and is distributed according to a cumulative distribution function  $G(\cdot)$ , with density  $g(\cdot)$ , which allows for quite general demand functions; we only assume here that the inverse hazard rate,  $k(\cdot) \equiv G(\cdot)/g(\cdot)$ , is strictly increasing. Finally, we allow as before for general distributions of shopping costs (including bounded ones – see below).

One-stop shoppers are now willing to patronize  $L$  if:

$$t \leq v_{AL} - \frac{x}{\sigma} \iff x \leq \sigma(v_{AL} - t),$$

where as before  $v_{AL} = w_{AL} - r_{AL}$ . They also prefer this to patronizing  $S$  as long as:

$$v_{AL} - \frac{x}{\sigma} \geq v_S = w_S - r_S \iff x \leq \hat{x} \equiv \sigma(v_{AL} - v_S).$$

The potential one-stop shoppers are thus the consumers for whom:

$$x \leq x_{AL}(t) \equiv \sigma(v_{AL} - \max\{t, v_S\}).$$

Likewise, consumers prefer multi-stop shopping to patronizing  $L$  only if

$$t \leq \tau = v_S - w_L + r_L,$$

and prefer this to buying  $B_S$  only if the additional value from consuming  $A$  offsets the extra shopping cost:

$$t \leq v_A - \frac{x}{\sigma} \iff x \leq x_A(t) \equiv \sigma(v_A - t),$$

where  $v_A \equiv w_A - r_A$ . Therefore, as long as  $L$  attracts some one-stop shoppers ( $v_{AL} > v_S$ ) and  $S$  attracts some multi-stop shoppers ( $\tau > 0$ ), then (see Figure 1):

- consumers with  $t < \tau$  buy  $A$  from  $L$  and  $B_S$  from  $S$  if  $x < x_A(t)$  (region  $D_{AS}$ ), and only  $B_S$  otherwise (region  $D_S$ );
- consumers with  $\tau < t < v_{AL}$  and  $x < x_{AL}(t)$  buy both  $A$  and  $B_L$  from  $L$  (region  $D_{AL}$ ), and otherwise buy either  $B_S$  only (if  $t \leq v_S$ ) or nothing (if  $t > v_S$ ).

The corresponding demands are portrayed in Figure 1.

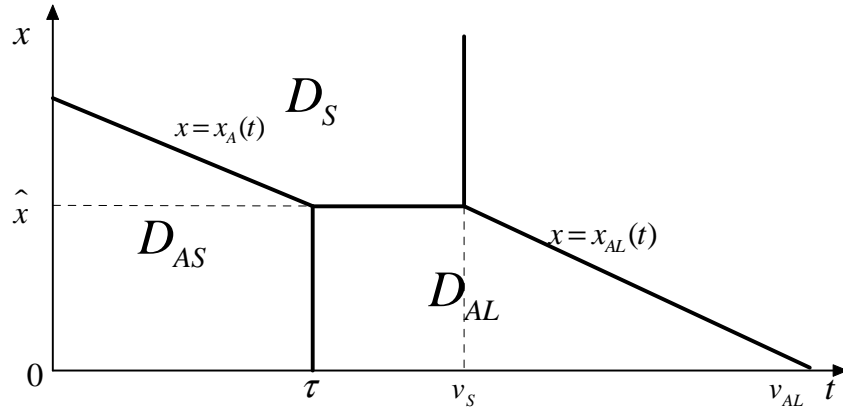


Figure 1: Heterogeneous valuations for  $A$

This description applies as well when the shopping cost  $t$  is bounded, truncating if necessary the relevant interval for  $t$ . For example, if the shopping cost is distributed over  $[0, T]$ , where

$T < v_S$ , then all consumers are willing to buy  $B_S$  from  $S$ ; therefore, market  $B$  is always entirely served, by either a small or a large retailer. In addition, some consumers (those with a higher taste for  $A$  and/or lower shopping cost) will also buy  $A$  from  $L$ . More precisely, a consumer will buy  $A$  from  $L$  when  $x \leq x_A(t)$  if  $t < \tau$ , and when  $x \leq x_{AL}(t) (< x_A(t))$  if  $t \in [\tau, T]$  (in which case it will also buy  $B_L$  from  $L$ ).

We show in Appendix F that, in all these cases, introducing an elastic demand does not preclude the large retailer from adopting a loss-leading strategy, so as to extract additional surplus from multi-stop shoppers:

**Proposition 5** *Suppose that consumers have heterogeneous valuations for  $A$ . Then, as long as it attracts some one-stop shoppers in equilibrium, the large retailer adopts a loss-leading pricing strategy to exploit extra surplus from multi-stop shoppers.*

**Proof.** See Appendix F. ■

As before, keeping constant the total price for the assortment  $AB_L$  offered to one-stop shoppers, subsidizing  $B_L$  allows  $L$  to increase the price it charges to multi-stop shoppers on market  $A$ . By contrast with the previous case, however, increasing the price for  $A$  not only discourages multi-stop shopping, but also results in fewer sales, since the demand for  $A$  is now elastic. Yet, the analysis shows that multi-stop shoppers' demand is relatively less price-sensitive than the demand of one-stop shoppers, and as a result, subsidizing  $B$  to increase the price of  $A$  remains a profitable strategy. More precisely:

- In the range  $t \in [0, \tau]$ , the marginal consumer is a multi-stop shopper located at  $x = x_A(t) = \sigma(v_A - t)$ ; an increase in the relevant margin  $r_A$  thus generates a loss of demand  $-\sigma g(x_A(t))$  but increases the profit achieved on the mass  $G(x_A(t))$  of consumers that actually buy. Thus, if the retailers could charge customized margins, tailored to the shopping cost, they would adopt  $r_A(t) = G(x_A(t)) / \sigma g(x_A(t)) = k(x_A(t)) / \sigma$ .
- Similarly, in the range  $t \in [\tau, v_{AL}]$ , the marginal consumer is a one-stop shopper located at  $x = x_{AL}(t) = \sigma v_{AL} - \sigma \max\{t, v_S\}$ , and the optimal customized margin would thus be  $r_{AL}(t) = k(x_{AL}(t)) / \sigma$ .

By construction,  $x_A(\cdot)$  and  $x_{AL}(\cdot)$  decrease as  $t$  increases and coincide at  $t = \tau$  (see Figure 1);<sup>38</sup> the monotonicity of the hazard rate thus implies that  $L$  wants to charge higher margins to multi-stop shoppers ( $t < \tau$ ) than to one-stop shoppers ( $t > \tau$ ), which requires subsidizing  $B_L$ .

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<sup>38</sup>That is, consumers who face a higher shopping cost are less likely to buy and/or to visit multiple stores.



## 6.2 Competition among large retailers

Suppose now that two large retailers are present,  $L_1$  and  $L_2$ , who incur the same costs in distributing  $A$  and  $B$ , and offer the same variety  $B_L$  but differentiated varieties  $A_1$  and  $A_2$ : a consumer with preference  $x$  then obtains a utility  $u_A - \frac{x}{\sigma} - p_{A_1} = w_A - r_{A_1} - \frac{x}{\sigma}$  from buying  $A_1$  and a utility  $w_A - r_{A_2} - \frac{1-x}{\sigma}$  from buying  $A_2$ . We will restrict attention to symmetric distributions (that is, the density  $g(\cdot)$  satisfies  $g(x) = g(1-x)$ ) and will focus on (symmetric) equilibria in which: (i) the large retailers compete against each other as well as against their smaller rivals; (ii) small retailers attract some multi-stop shoppers by offering a value  $v_S$  that exceeds the value  $v_L$  offered by large retailers on the  $B$  market; and (iii) large retailers attract some one-stop shoppers by offering them a value  $v_{AL}$  that exceeds  $v_S$ , as well as the value  $v_A$  that they offer on the  $A$  market alone.

Large retailers may compete against each other for one-stop and/or for multi-stop shoppers. In the former case, in a symmetric equilibrium (of the form  $r_{A_1L_1} = r_{A_2L_2} = r_{AL}$  and  $r_{L_1} = r_{L_2} = r_L$ ) some consumers (with  $x = 1/2$ ) are indifferent between buying both goods from either  $L_1$  or  $L_2$ , and prefer doing so to patronizing  $S$  only; this implies (using  $x = 1/2$ , and dropping the subscripts 1 and 2 for ease of exposition):

$$\hat{v}_{AL} \equiv v_{AL} - \frac{1}{2\sigma} \geq v_S,$$

which is equivalent to

$$\hat{v}_A \equiv v_A - \frac{1}{2\sigma} \geq \tau = v_S - v_L.$$

Therefore, consumers with preference  $x = 1/2$  and shopping cost  $t < \tau$ , who thus prefer multi-stop shopping (that is, buying  $B_S$  from  $S$  and  $A$  from either  $L_1$  or  $L_2$ ) to visiting  $L_1$  or  $L_2$  only, also prefer multi-stop shopping to patronizing  $S$  only (since  $t < \tau$  then implies  $t < \hat{v}_A$ ). In other words, if large retailers compete for one-stop shoppers, they will also compete for multi-stop shoppers. This observation allows us to classify the (symmetric) candidate equilibria into two types:

- Type  $M$ : large retailers compete only for *multi-stop* shoppers;
- Type  $O$ : large retailers compete for *one-stop* shoppers as well as for multi-stop shoppers.

In the first type of equilibria (which is illustrated in Figure 2), for  $x = 1/2$  some consumers with low shopping costs are indifferent between assortments  $A_1S$  and  $A_2S$ , and prefer those

assortments to any other option, whereas consumers with higher shopping costs patronize  $S$  only; the relevant threshold for the shopping cost satisfies

$$\hat{v}_A + v_S - 2t = v_S - t,$$

that is,  $t = \hat{v}_A$ . Consumers with  $t < \hat{v}_A$  thus buy  $B$  from  $S$  and  $A$  from either  $L_1$  or  $L_2$  (depending on whether  $x$  is smaller or larger than  $1/2$ ). Conversely, consumers whose shopping costs exceed  $v_{AL}$  do not shop. As for consumers whose shopping costs lie between  $\hat{v}_A$  and  $v_{AL}$ :

- when  $t < \tau$ , consumers still buy  $B_S$  from  $S$ ; they also buy  $A$  from  $L_1$  if  $x < x_A(t) = \sigma(v_A - t)$ , or from  $L_2$  if  $x > 1 - x_A(t)$ ;
- when  $t > \tau$ :
  - if  $x < x_{AL}(t)$ , consumers buy both goods from  $L_1$ ;
  - if  $x > 1 - x_{AL}(t)$ , consumers buy both goods from  $L_2$ ;
  - if  $x_{AL}(t) < x < 1 - x_{AL}(t)$ , consumers patronize  $S$  if  $t < v_S$ , and buy nothing otherwise.

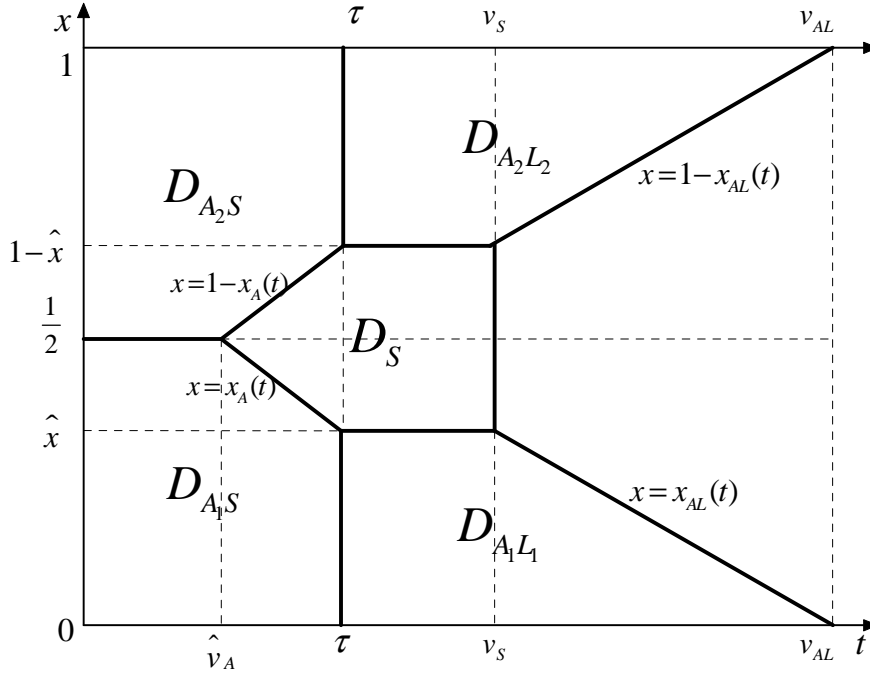


Figure 2: Large retailers competing for multi-stop shoppers

In the second type of equilibria (illustrated in Figure 3), all consumers with a shopping cost  $t < \tau$  buy  $B_S$  from  $S$  and  $A$  from either  $L_1$  (if  $x < 1/2$ ) or  $L_2$  (if  $x > 1/2$ ), while consumers with  $t > v_{AL}$  buy nothing. For consumers with  $\tau < t < v_{AL}$ , then:

- if  $t < \hat{v}_{AL}$ , consumers will buy both goods from either  $L_1$  (if  $x < 1/2$ ) or  $L_2$  (if  $x > 1/2$ );
- if  $\hat{v}_{AL} < t < v_{AL}$ , consumers will buy both goods from  $L_1$  if  $x < x_{AL}(t)$  or from  $L_2$  if  $x > 1 - x_{AL}(t)$ , and buy nothing otherwise.

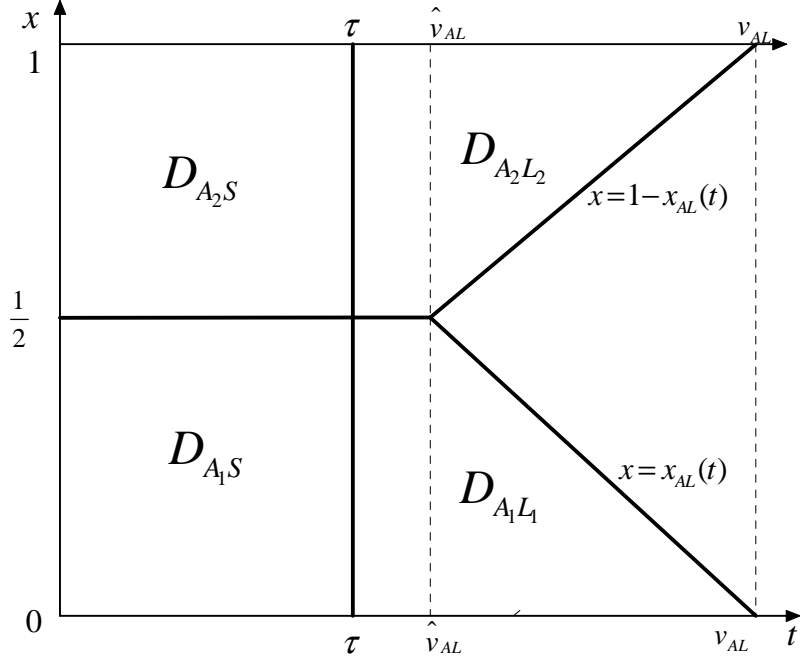


Figure 3: Large retailers competing for both types of consumers

A similar description applies when the shopping cost  $t$  is bounded, truncating as necessary the interval for  $t$ . We show in the Appendix G that loss leading is still used as an exploitative device:

**Proposition 6** *Suppose that large retailers compete against each other as well as against their smaller rivals. Then, large retailers adopt a loss-leading pricing strategy in any symmetric equilibrium in which they attract some one-stop shoppers.*

**Proof.** See Appendix G. ■

While competition here limits large retailers' margins (on  $A$  as well as on the assortment  $AL$ ), loss leading still allows them to better discriminate consumers according to their shopping costs. Pricing  $B_L$  below cost, and increasing the price of  $A$  so as to maintain  $r_{AL}$  unchanged, does not affect one-stop shoppers, who are still willing to buy  $A$ , but allows large retailers to extract more surplus from multi-stop shoppers who only buy product  $A$  from them. While this strategy may also encourage some multi-stop shoppers to switch to the other large retailer as well as to stop

buying  $A$ , the analysis shows that multi-stop shoppers remain less price-sensitive than one-stop shoppers; as a result, large retailers aim again at charging greater margins on them, and the loss-leading strategy remains profitable. The use of loss leading as an exploitative device thus appears quite robust in market environments where large retailers compete imperfectly against each other and face smaller rivals who are more efficient in distributing a narrower range of products.

## 7 Applications

### 7.1 Competition versus acquisition

In practice, the retail chains operating large stores have often entered into smaller-scale retail markets, either by setting-up their own discount or specialist stores or by merging with existing chains of small stores. For instance, the French leading retailer, Carrefour, has created the discount chain LeaderPrice, which provides a short range of staples with lower prices and competes face to face with traditional discounters such as Lidl in some local markets, and more recently has started to open smaller stores (under the names "Carrefour City" and "Carrefour Market"). We analyze here the impact of such entry on retail competition, by assuming that  $L$  can either open (at no cost) a smaller but more efficient format similar to  $S$ , or acquire such a store. We consider several initial situations.

In local markets where  $L$  faces a competitive fringe of small rivals, opening yet another store would have no effect on firms' profits and consumer surplus. By contrast, in markets where  $L$  initially enjoys a monopoly position, opening a smaller store generates extra profit through a better screening of consumers. As long as  $L$  enjoys a comparative advantage for one-stop shoppers (i.e.,  $w_{AL} > w_S$ ), it is optimal to induce them to patronize  $L$ , and use  $S$  to cater to multi-stop shoppers. The total profit is then given by:

$$\Pi_L + \Pi_S = r_{AL} (F(v_{AL}) - F(\tau)) + (r_S + r_A) F(\tau),$$

where the first term is the profit from one-stop shoppers, while the second term is that from multi-stop shoppers. Using  $r_A = r_{AL} - r_L$ , it can be rewritten as:

$$\Pi_L + \Pi_S = r_{AL} F(v_{AL}) + (r_S - r_L) F(\tau).$$

It is thus optimal to charge  $r_{AL} = r_{AL}^m$  and  $r_L - r_S = -h(\tau^*)$ , where  $\tau^* = l^{-1}(w_S - w_L)$ , and in

this way  $L$  and  $S$  generate a joint profit equal to  $\Pi_L^* = \Pi_{AL}^m + h(\tau^*) F(\tau^*)$ .<sup>39</sup> Since it does not affect the value of one-stop shopping, but transforms some consumers into multi-stop shoppers, opening the small store enhances consumer surplus and total welfare as well as it improves profit.

Whenever  $L$  faces a single small store in a local market, it will adopt a loss-leading strategy if its comparative advantage is large enough (namely, if  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ ), and obtains in this way a profit  $\hat{\Pi}_L^* = \Pi_{AL}^m + h(\hat{\tau}^*) F(\hat{\tau}^*)$ , which is lower than in the case of a competitive fringe, as the strategic response of  $S$  reduces the extra profit that  $L$  can extract from multi-stop shoppers. Opening a small store to compete head to head with  $S$  would then reduce the margin  $r_S$  down to zero, and thus restore  $L$ 's ability to extract  $h(\tau^*) F(\tau^*)$  from multi-stop shoppers. However, as the resulting competition may also constrain  $L$ 's pricing policy towards one-stop shoppers (if  $w_{AL} < l(w_S)$ ,  $L$  must lower its total margin below  $r_{AL}^m$  so as to match the value that one-stop shoppers would get from  $S$ ), this is profitable only when  $L$ 's comparative advantage is strong enough.<sup>40</sup> As the competition fosters multi-stop shopping (the shopping cost threshold increases from  $\hat{\tau}^*$  to  $\tau^*$ ), and can only have a positive impact on one-stop shopping, it also enhances consumer surplus as well as total welfare. Alternatively,  $L$  may instead acquire  $S$ , in which case  $L$  and  $S$  could together generate again a total profit of  $\Pi_L^*$ . This scenario is equivalent to opening a new store if  $L$ 's comparative advantage is particularly large (namely,  $w_{AL} \geq l(w_S)$ ), otherwise the merger is more profitable as it avoids the competitive constraint on the price charged to one-stop shoppers. In both cases, however, consumers and society would benefit from such a merger, which would again foster multi-stop shopping (if  $w_{AL} < l(w_S)$ , then consumers and society would however benefit even more from the opening of an additional store competing with  $S$ ).

The following proposition summarizes this discussion:

**Proposition 7** *In local markets in which there is initially imperfect competition in the B segment, whenever it enjoys a large enough comparative advantage, the large retailer can then benefit from either opening or acquiring a smaller but more efficient store, and this also enhances consumer surplus and total welfare.*

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<sup>39</sup>This profit corresponds to what  $L$  would obtain when facing a competitive fringe of small stores, provided it benefits from a large enough comparative advantage (namely, if  $v_{AL}^m \geq w_S$ ); otherwise competition would partly dissipate this profit.

<sup>40</sup>This is clearly the case when  $w_{AL} \geq l(w_S)$ , since then  $v_{AL}^m = l^{-1}(w_{AL}) \geq w_S$  and  $L$  thus obtains  $\Pi_L^* = \Pi_{AL}^m + h(\tau^*) F(\tau^*)$  when smaller rivals charge  $r_S = 0$ ; by continuity, this is still the case when  $w_{AL}$  is not excessively lower than  $l(w_S)$ .

## 7.2 Complementary goods and adoption costs

While we have focused here on the case where  $A$  and  $B$  are independent goods or partial substitutes, the analysis applies also – even more straightforwardly – to the case of complements. Suppose for example that  $A$  is a prerequisite for using  $B$  (as in the case of CD players and speakers): product  $B$  has no value on a stand-alone basis ( $u_L = u_S = 0$ ), and must be used together with product  $A$  (with  $w_{AS} = u_{AS} - c_A - c_S > w_{AL} = u_{AL} - c_A - c_L$ ).<sup>41</sup> Denoting by  $w_S$  (resp.  $w_L$ ) the additive value for using  $B_S$  (resp.  $B_L$ ) on top of product  $A$ , the above analysis goes through, except that one-stop shoppers necessarily favor  $L$  (since there is no value in patronizing  $S$  only). Regime  $L$  thus systematically prevails, and as a result,  $L$  always engages in loss leading: it charges the monopoly margin  $r_{AL}^m$  for the bundle and a negative margin,  $r_L^* = -h(\tau^*)$ , for  $B_L$ .

Also, while we have focused so far on retail markets, the insights apply to industries in which the costs of adopting a technology, of learning how to use a product, of maintaining equipment, and so forth, play a role similar to the shopping costs that consumers incur to visit an additional store. These insights can therefore shed a new light on famous antitrust cases such as the *Microsoft* saga, in which Microsoft has been accused of excluding rivals in adjacent markets – e.g., the markets for browsers or media players. While the arguments mainly focused there on the rationality of an exclusionary conduct, our analysis suggests an alternative motivation for subsidizing or otherwise encouraging customers to adopt the platform developer's own application, to the detriment of its rivals.

To see this, suppose that  $L$  runs a platform  $A$  and offers an application  $B_L$  that competes with a fringe of rivals' applications  $B_S$ , and consider first a simple example where: (i)  $A$  and  $B$  are perfect complements (that is,  $u_A = u_L = u_S = 0$ ), and (ii) rivals offer a better product ( $w_{AS} > w_{AL}$ ), but (iii) adopting a rival application (which may involve a different environment, or switching and learning costs in case of entry) involves a cost  $t$  that varies across customers according to the distribution  $F(\cdot)$ . Our analysis then carries through. By construction, customers purchase either  $AL$  or  $AS$ , and favor "mix-and-match" when  $t < \tau = w_{AS} - w_{AL} + r_L$ ; as long as  $L$  sells its application (i.e.,  $r_{AL} \leq w_{AL}$ ), it obtains a profit equal to:

$$\Pi_L = r_A F(\tau) + r_{AL} (1 - F(\tau)) = r_{AL} - r_L F(\tau).$$

$L$ 's optimal pricing policy thus consists in charging the full price for the bundle ( $r_{AL} = w_{AL}$ )

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<sup>41</sup>The analysis applies irrespective of whether  $A$  generates or not a value on a stand-alone basis, as long as combining it with  $B$  generates a higher value.

and subsidizing its application:  $r_L = -h(\tau^*)$ , where as before  $\tau^* = l^{-1}(w_{AS} - w_{AL})$ .

While the cost of adopting  $L$ 's application was for simplicity assumed to be constant, the insight carries over to situations where both adoption costs vary across customers, as long as adopting a rival application involves a higher cost. For example, if adopting  $L$ 's or the rivals' applications involve costs  $\alpha t$  and  $(1 + a)t$ , respectively, then the mix-and-match threshold  $\tau$  remains unchanged, and the analysis parallels that of asymmetric shopping costs (see the remark at the end of section 3).

Similar insights also apply to industries in which procuring several categories of products from the same supplier allows a customer to save on operating costs. For example, in its decision on the proposed merger between Aerospatiale-Alenia and De Havilland,<sup>42</sup> the European Commission mentions that the new entity would benefit from being the only one to offer regional aircraft in all three relevant sizes, thus allowing "one-stop shopper" airlines to save on maintenance and spare parts as well as on pilot training and certification. To see how the analysis can be transposed in such industries, suppose for instance that  $L$  covers both segments  $A$  and  $B$  while  $S$  covers  $B$  only, and that procuring both products from the same supplier involves a maintenance cost  $f$ , while dealing with different suppliers increases the maintenance cost to  $f + t$ , where  $t$  is customer-specific. Then, whenever active customers prefer procuring both products (e.g., because the products are complements, or because airlines cannot be viable without operating aircraft in all relevant sizes), the same analysis as above applies, and  $L$  subsidizes again the competitive product (and charges for example the full value for the bundle if  $f$  is constant and the goods are complements, or mimics the pricing policy with asymmetric shopping costs if  $f$  is proportional to  $t$ ).

## 8 Conclusion

Large retailers, enjoying substantial market power in some local markets, often compete with smaller retailers who carry a narrower range of products in a more efficient way. We find that these large retailers can exercise their market power by adopting a loss-leading pricing strategy, which consists of pricing below cost some of the products also offered by smaller rivals, and raising the prices on the other products. In this way the large retailers can better discriminate multi-stop shoppers from one-stop shoppers – and may even earn more profit than in the absence

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<sup>42</sup>See the decision of the European Commission of 2 October 1991 in case No. IV/M053 - Aerospatiale-Alenia/de Havilland.

of the more efficient rivals. Loss leading thus appears as an exploitative device, designed to extract additional surplus from multi-stop shoppers, rather than as an exclusionary instrument to foreclose the market, although the small rivals are hurt as a by-product of exploitation. We show further that banning below-cost pricing increases consumer surplus, small rivals' profits, and social welfare.

Our analysis sheds a new light on the potential harm of loss leading and identifies the key factors underlying it: asymmetry in the product range and heterogeneity in consumers' shopping patterns.<sup>43</sup> While the insights are quite robust to variations in cost and demand conditions, policy measures should however also take into account potential efficiency justifications, and empirical studies are needed to assess the resulting balance. We have furthermore restricted attention to individual unit demands, as this appears reasonable for groceries and other day-to-day purchases, and also neglected any correlation between consumers' valuations for the goods and their shopping costs; whether our insights apply to market environments where consumers' individual demands are elastic, or underlying characteristics (e.g., wealth) affect both shopping costs and willingness to pay, is left to future research. Likewise, our framework focuses on small retailers who offer higher quality and/or lower distribution cost, such as specialist chains and hard discount stores, but it does not account for other categories of small stores, such as convenience stores, who face higher distribution cost (and charge higher prices) but allow consumers to save on shopping costs; we leave to future research the analysis of pricing strategies in such instances.

Finally, while the analysis focuses mainly on retail markets, our insights apply as well to industries where a firm, enjoying substantial market power in one segment, competes with more efficient rivals in other segments, and procuring these products from the same supplier generates customer-specific benefits. They also apply to complementary products, such as platforms and applications. While some of these industries have hosted heated antitrust cases focusing on predatory pricing or related conduct, our analysis provides an alternative rationale for below-cost pricing based on exploitation rather than exclusion.

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<sup>43</sup>We have focused here on different shopping costs, which appear as a key factor for routine, repeated purchases. Other sources of heterogeneity may be relevant for other types of purchases; for example, for less frequent, high value purchases, information and search costs may play a more important role – and customers with lower search costs are again likely to visit more stores. It would be interesting to study whether these alternative sources of underlying heterogeneity yield similar or distinct insights.



# Appendices

## A Quasi-concavity of profit functions

We check here the quasi-concavity of the profit functions. In the monopoly case, it is optimal for  $L$  to choose  $r_{AL} < w_{AL}$  (otherwise, it would make no profit), which yields a profit:

$$\Pi(r_{AL}) = r_{AL}F(w_{AL} - r_{AL}).$$

Differentiating with respect to  $r_{AL}$  yields:

$$\Pi'(r_{AL}) = f(w_{AL} - r_{AL})\phi(r_{AL}),$$

where the function  $\phi(r_{AL}) \equiv h(w_{AL} - r_{AL}) - r_{AL}$  is strictly decreasing; therefore, the first-order condition, which boils down to  $\phi(r_{AL}) = 0$ , has a unique solution  $r_{AL}^m = h(v_{AL}^m)$ , where  $v_{AL}^m = l^{-1}(w_{AL})$ ,<sup>44</sup> and the profit function  $\Pi$  is strictly quasi-concave in the relevant range  $r_{AL} \leq w_{AL}$ . The solution  $r_{AL}^m$  thus constitutes a global optimum.

In regime  $L$ , as long as  $\tau = w_S - w_L + r_L - r_S$  lies between 0 and  $v_{AL} = w_{AL} - r_{AL}$ ,  $L$ 's profit can be expressed as:

$$\Pi_L(r_{AL}, r_L) = r_{AL}F(w_{AL} - r_{AL}) - r_LF(w_S - w_L + r_L - r_S),$$

which is thus additively separable with respect to  $r_{AL}$  and  $r_L$ . Using the same argument as above, the terms  $r_{AL}F(w_{AL} - r_{AL})$  and  $-r_LF(w_S - w_L + r_L - r_S)$  are moreover quasi-concave in, respectively,  $r_{AL}$  and  $-r_L$ . It follows that  $L$ 's unique best response to  $r_S$  is characterized by  $r_{AL}^m = h(w_{AL} - r_{AL}^m)$  and  $r_L^* = -h(w_S - w_L + r_L^* - r_S)$ . A similar reasoning applies to regime  $S$ . Likewise, when the small retailer is a strategic player, its best response maximizes  $\Pi_S = r_SF(w_S - w_L + r_L - r_S)$ , which is quasi-concave in  $r_S$ , and is thus the solution to  $r_S^* = h(w_S - w_L + r_L - r_S^*)$ .

## B Proof of Proposition 1

We first show that, without loss of generality, we can focus on  $\tau \in [0, v_{AL}]$ . If  $\tau > v_{AL}$  (i.e.,  $w_S - w_L + r_L > w_{AL} - r_{AL}$ , or  $r_L > r_L' \equiv (w_{AL} - r_{AL} - (w_S - w_L))/2$ ), there are no one-stop shoppers: active consumers buy  $A$  from  $L$  and  $B_S$  from  $S$ , and do so as long as  $2t < v_{AS}$ ;

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<sup>44</sup>Using  $r_{AL} + v_{AL} = w_{AL}$ , the first-order condition can be written as  $h(v_{AL}) = r_{AL} = w_{AL} - v_{AL}$ , that is,  $w_{AL} = v_{AL} + h(v_{AL}) = l(v_{AL})$ .

however, keeping  $r_A$  constant, decreasing  $r_L$  to  $r'_L$  such that  $\tau' = v'_{AL}$  does not affect the number of active consumers (since  $v_{AS}$  does not change), who still visit both stores as before. If instead  $\tau < 0$  (i.e.,  $r_L < -w_S - w_L$ ), there are no multi-stop shoppers: active consumers only visit  $L$ , and do so as long as  $t < v_{AL}$ ; however, keeping  $r_A$  constant, increasing  $r_L$  to  $r'_L = -(w_S - w_L)$  yields  $\tau' = 0$  without affecting consumer behavior.

The optimal margins and profits for the regimes  $L$  and  $S$  are characterized in the text. The loss-leading strategy is clearly preferable when  $v_{AL}^m \geq w_S$ , since it then gives  $L$  more profit than the monopolistic profit  $\Pi_{AL}^m$ , which exceeds the monopoly profit that could be achieved in market  $A$  only ( $\Pi_A^m$ ):  $\Pi_{AL}^m = \max_r rF(w_{AL} - r) > \max_r rF(w_A - r) = \Pi_A^m$  since  $w_{AL} > w_A$ . We now show that the loss-leading strategy remains profitable when  $w_{AL} \geq w_S > v_{AL}^m$ , where it involves  $r_L^* < 0$  and  $\tilde{r}_{AL}^* = w_{AL} - w_S$ . To see this, fixing  $\tilde{r}_{AL}^*$  and using  $r_A$  rather than  $r_L$  as the optimization variable, the margin on  $B_L$  and the shopping cost threshold can be expressed as:

$$r_L = r_{AL} - r_A = w_{AL} - w_S - r_A, \tau = w_S - w_L + r_L = w_{AL} - w_L - r_A.$$

Then, the maximum profit  $\tilde{\Pi}_L^*$  can then be written as:

$$\begin{aligned} \tilde{\Pi}_L^* &= \tilde{r}_{AL}^* (F(\tilde{v}_{AL}^*) - F(\tau^*)) + r_A^* F(\tau^*) \\ &= (w_{AL} - w_S) (F(w_S) - F(\tau^*)) + r_A^* F(\tau^*) \\ &= \max_{r_A} \{ (w_{AL} - w_S) (F(w_S) - F(w_{AL} - w_L - r_A)) + r_A F(w_{AL} - w_L - r_A) \} \\ &\geq (w_{AL} - w_S) (F(w_S) - F(w_{AL} - w_L - r_A^m)) + r_A^m F(w_{AL} - w_L - r_A^m) \\ &= (w_{AL} - w_S) (F(w_S) - F(v_A^m)) + \Pi_A^m. \end{aligned}$$

Since  $w_S > v_{AL}^m = l^{-1}(w_{AL}) > l^{-1}(w_{AL} - w_L) = v_A^m$ , it follows that  $\tilde{\Pi}_L^* \geq \Pi_A^m$  whenever  $w_{AL} \geq w_S$ .

Conversely, when  $w_{AL} < w_S$ , we have:

$$\begin{aligned} \tilde{\Pi}_L^* &= (w_{AL} - w_S) (F(w_S) - F(w_{AL} - w_L - \tilde{r}_A^*)) + \tilde{r}_A^* F(w_{AL} - w_L - \tilde{r}_A^*) \\ &< \tilde{r}_A^* F(w_{AL} - w_L - \tilde{r}_A^*) \\ &\leq \Pi_A^m, \end{aligned}$$

where the first inequality stems from  $w_S > w_{AL} (> w_{AL} - w_L - \tilde{r}_A^*)$ .

Finally, in the limit case where  $w_{AL} = w_S$ , using  $B_L$  as a loss leader amounts to monopolizing product  $A$ . Notice that offering  $v_{AL} = w_S$  requires  $r_{AL} = w_{AL} - v_{AL} = 0$ , or  $r_A = -r_L$ , thus the margin on  $A$  reflects the subsidy on  $B_L$ . In this case, the optimal subsidy strategy maximizes

$-r_L F(\tau) = -r_L F(w_S - w_L + r_L) = r_A F(w_{AL} - w_L - r_A)$ . Consumers are also indifferent between these two strategies: in both cases they face the same price for  $A$ . While the loss-leading strategy may yield a lower price for  $B_L$  (in the monopolization scenario,  $L$  may actually stop carrying  $B_L$ ), this does not affect multi-stop shoppers (who do not buy  $B_L$  from  $L$ ), whereas one-stop shoppers are indifferent between buying  $A$  and  $B_L$  from  $L$  or  $B_S$  only from  $S$ .

## C Proof of Proposition 2

We derive here the conditions under which the loss leading outcome ( $\hat{r}_{AL}^* = r_{AL}^m$  and  $\hat{r}_L^* = -\hat{r}_S^* = -h(\hat{\tau}^*)$ , where  $\hat{\tau}^* = j^{-1}(w_S - w_L)$ ) forms a Nash equilibrium, before checking the uniqueness of the equilibrium. To attract one-stop shoppers,  $L$  must offer a better value than  $S$ :<sup>45</sup>

$$v_{AL}^m \geq \hat{v}_S^* \equiv w_S - h(\hat{\tau}^*). \quad (12)$$

This condition implies  $v_{AL}^m \geq \hat{v}_S^* > \hat{v}_S^* - \hat{v}_L^* = \hat{\tau}^*$ , which in turn implies  $w_{AL} > w_S$ :

$$w_{AL} = l(v_{AL}^m) \geq l(\hat{v}_S^*) = \hat{v}_S^* + h(\hat{v}_S^*) = w_S - h(\hat{\tau}^*) + h(\hat{v}_S^*) > w_S.$$

Moreover, while  $L$  has no incentive to exclude its rival, since it earns more profit than a pure monopolist,  $S$  may want to attract one-stop shoppers by reducing  $r_S$  so as to offer  $v_S \geq v_{AL}^m$ . Such a deviation allows  $S$  to attract all consumers (one-stop or multi-stop shoppers) with shopping costs  $t \leq v_S$  and thus yields a profit  $\Pi_S^d(v_S) \equiv r_S F(v_S) = (w_S - v_S) F(v_S)$ . It is easy to check that the best deviation of this type is to offer  $v_S^d = v_{AL}^m$  (or slightly above  $v_{AL}^m$ , if one-stop shoppers are indifferent between two stores in this case). To see this, note that  $\Pi_S^d(v_S)$  is quasi-concave in  $v_S$  and let  $v_S^m$  denote the optimal value of  $v_S$ . Since the candidate equilibrium margin,  $\hat{v}_S^*$ , maximizes  $(w_S - w_L + \hat{r}_L^* - v_S) F(v_S)$ , where  $w_S - w_L + \hat{r}_L^* < w_S$ , a simple revealed argument yields  $v_S^m < \hat{v}_S^*$ . Thus, increasing  $v_S$  further above  $v_{AL}^m > \hat{v}_S^*$  would reduce  $S$ 's profit monotonically, and it is then optimal for  $S$  to offer precisely  $v_S^d = v_{AL}^m$ , which gives  $S$  a profit equal to  $\Pi_S^d(v_{AL}^m) = (w_S - v_{AL}^m) F(v_{AL}^m)$ . Thus, the loss-leading outcome is immune to such a deviation if and only if

$$\hat{\Pi}_S^* \equiv h(\hat{\tau}^*) F(\hat{\tau}^*) \geq \hat{\Pi}_S^d \equiv (w_S - v_{AL}^m) F(v_{AL}^m). \quad (13)$$

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<sup>45</sup> As before, this is equivalent to  $w_{AL} - w_L - \hat{r}_A^* = v_{AL}^m - \hat{v}_L^* \geq \hat{v}_S^* - \hat{v}_L^* = \hat{\tau}^* (> 0)$ , which implies that multi-stop shoppers are indeed willing to buy  $A$  when visiting  $L$ . Moreover, this condition also implies  $v_{AL}^m > \hat{v}_S^* - \hat{v}_L^* = \hat{\tau}^* (> 0)$ .

This condition can be further written as:

$$\Psi(w_{AL}; w_S) \equiv (w_S - v_{AL}^m) F(v_{AL}^m) \leq \hat{\Pi}_S^*, \quad (14)$$

where  $v_{AL}^m = l^{-1}(w_{AL})$  and thus satisfies  $v_{AL}^m + h(v_{AL}^m) = w_{AL}$ . Therefore:

$$\begin{aligned} \frac{\partial \Psi}{\partial w_{AL}}(w_{AL}; w_S) &= ((w_S - v_{AL}^m) f(v_{AL}^m) - F(v_{AL}^m)) \frac{dv_{AL}^m}{dw_{AL}} \\ &= (w_S - v_{AL}^m - h(v_{AL}^m)) \frac{f(v_{AL}^m)}{1 + h'(v_{AL}^m)} \\ &= (w_S - w_{AL}) \frac{f(v_{AL}^m)}{1 + h'(v_{AL}^m)}. \end{aligned}$$

It follows that, in the range  $w_{AL} \geq w_S$ ,  $\Psi(w_{AL}; w_S)$  decreases with  $w_{AL}$  (and strictly so for  $w_{AL} > w_S$ ). Thus, condition (13) amounts to  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ , where  $\hat{w}_{AL}(w_S, w_L)$  is the unique solution to  $\Psi(w_{AL}; w_S) = \hat{\Pi}_S^*$ . To show that this solution exists and lies above  $w_S$ , note first that  $\Psi$  becomes negative for  $w_{AL} > l(w_S)$  (since then  $v_{AL}^m = l^{-1}(w_{AL}) > w_S$ ), and that for  $w_{AL} = w_S$ ,  $\Psi(w_{AL}; w_S) = (w_{AL} - v_{AL}^m) F(v_{AL}^m) = \Pi_{AL}^m = \max_v (w_{AL} - v) F(v)$ ; since  $w_{AL} > w_S - w_L + \hat{r}_L^*$ , this exceeds  $\hat{\Pi}_S^* = \max_\tau (w_S - w_L + \hat{r}_L^* - \tau) F(\tau)$ .

Finally, in the range  $w_{AL} > w_S (> w_S - \hat{v}_L^*)$ , a simple revealed argument yields:

$$\hat{\tau}^* = \arg \max_v (w_S - \hat{v}_L^* - \tau) F(\tau) < v_{AL}^m = \arg \max_v (w_{AL} - v) F(v).$$

Therefore, (13), which is equivalent to:

$$v_{AL}^m \geq w_S - \frac{h(\hat{\tau}^*) F(\hat{\tau}^*)}{F(v_{AL}^m)}, \quad (15)$$

implies (12). The two conditions (12) and (13) thus boil down to  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ .

It remains to show that  $\hat{w}_{AL}(w_S, w_L)$  increases with  $w_S$ . Differentiating  $\hat{w}_{AL}(w_S, w_L)$  with respect to  $w_S$  yields:

$$\frac{\partial \hat{w}_{AL}}{\partial w_S} = \frac{\frac{\partial \Psi}{\partial w_S} - \frac{\partial \hat{\Pi}_S^*}{\partial w_S}}{-\frac{\partial \Psi}{\partial w_{AL}}},$$

where the denominator is positive in the relevant range, whereas the numerator is equal to:

$$\begin{aligned} \frac{\partial \Psi}{\partial w_S} - \frac{\partial \hat{\Pi}_S^*}{\partial w_S} &= F(v_{AL}^m) - \frac{d(h(\hat{\tau}^*) F(\hat{\tau}^*))}{d\hat{\tau}^*} \frac{\partial \hat{\tau}^*}{\partial w_S} \\ &= F(v_{AL}^m) - \frac{1 + h'(\hat{\tau}^*)}{1 + 2h'(\hat{\tau}^*)} F(\hat{\tau}^*), \end{aligned}$$

which is positive since  $v_{AL}^m > \hat{\tau}^*$ .

We now show that no other equilibrium exists when  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ . First, we turn to regime  $S$ , in which one-stop shoppers patronize  $S$  ( $v_{AL} < v_S$ ), and show that there is no

such equilibrium when  $w_{AL} > w_S$ . In this regime,  $L$  faces only a demand  $F(v_A)$  for  $A$  from multi-stop shoppers, where  $v_A = w_{AL} - w_L - r_A$ , and thus makes a profit equal to  $r_A F(v_A)$ .  $L$  could however deviate and attract one-stop shoppers by reducing  $r_L$  (keeping  $r_A$  and thus  $v_A$  constant) so as to offer  $v'_{AL} = v_S$  (or slightly above  $v_S$ ). Doing so would not change the number of multi-stop shoppers, since  $\tau' = v_S - v'_L = v'_{AL} - v'_L = v'_A = v_A$ , and  $L$  would obtain the same margin,  $r_A$ , from those consumers. But it would now attract one-stop shoppers (those for which  $v_A \leq t \leq v_{AL} = v_S$ ), from which  $L$  could earn a total margin  $r'_{AL} = w_{AL} - v'_{AL} = w_{AL} - v_S = w_{AL} - w_S + r_S$ . Since any candidate equilibrium requires  $r_S \geq 0$ , the deviation would be profitable when  $w_{AL} > w_S$ .

Second, consider the boundary between the two regimes, in which one-stop shoppers are indifferent between visiting  $L$  or  $S$  ( $v_{AL} = v_S$ ). Note that there must exist some active consumers, since either retailer can profitably attract consumers by charging a small positive margin; therefore, we must have  $v_{AL} = v_S > 0$ . Suppose that all active consumers are multi-stop shoppers (in which case  $L$  only sells  $A$  while  $S$  sells  $B_S$  to all consumers), which requires  $v_{AL} = v_S \leq \tau$ . Applying the same logic as in the beginning of Appendix B, we can without loss of generality focus on the case  $v_{AL} = v_S = \tau$ . It is then profitable for  $L$  to transform some multi-stop shoppers into one-stop shoppers, by reducing its margin on  $B_L$  to  $r'_L = w_L - \varepsilon > 0$  and increasing  $r_A$  by  $\varepsilon$ , so as to keep  $v_{AL}$  constant: doing so does not affect the total number of active consumers, but transforms those whose shopping cost lies between  $\tau' = v_S - v'_L = \tau - \varepsilon$  and  $\tau$  into one-stop shoppers. While  $L$  obtains the same margin on them (since  $r'_{AL} = r_{AL}$ ), it now obtains a higher margin  $r'_A > r_A$  on the remaining multi-stop shoppers.

Therefore, some consumers must visit a single store, and by assumption must be indifferent between visiting either store ( $v_{AL} = v_S$ ). Suppose now some one-stop shoppers visit  $S$ . Since  $S$  can avoid making losses, we must then have  $r_S \geq 0$ . But then,  $v_{AL} = v_S$  implies  $r_{AL} = r_S + w_{AL} - w_S > 0$  and, thus, it would be profitable for  $L$  to reduce  $r_{AL}$  slightly, so as to attract all one-stop shoppers. Therefore, all one-stop shoppers must go to  $L$  if  $r_{AL} > 0$ . Conversely, we must have  $r_S \leq 0$ , otherwise  $S$  would benefit from slightly reducing its margin so as to attract all one-stop shoppers. Therefore, in any candidate equilibrium such that  $v_{AL} = v_S > 0$ , either:

- There are some multi-stop shoppers (i.e.  $\tau > 0$ ) and thus  $r_S = 0$ ; but then, slightly increasing  $r_S$  would allow  $S$  to keep attracting some multi-stop shoppers and obtain a positive profit, a contradiction.
- Or, all consumers buy both products from  $L$ , which requires  $r_L \leq r_S - (w_S - w_L) \leq$

$-(w_S - w_L) < 0$ . But then, increasing  $r_L$  to  $r'_L = r_S - (w_S - w_L) + \varepsilon$  and reducing  $r_A$  by the same amount (so as to keep  $r_{AL}$  constant) would lead those consumers with  $t < \tau' = \varepsilon$  to buy  $B_S$  from  $S$ , allowing  $L$  to avoid granting them the subsidy  $r_L$ .

It follows that there is no equilibrium such that  $v_{AL} = v_S$ .

Finally, loss leading (in which  $L$  not only offers, but actually *sells* below cost) can only arise when  $L$  sells to one-stop shoppers, which thus requires  $v_{AL} \geq v_S$ . But this cannot be an equilibrium when  $w_{AL} < \hat{w}_{AL}(w_S, w_L)$ , since: (i) in the range  $v_{AL} > v_S$ , the only such candidate is the above described loss-leading outcome, which requires  $w_{AL} \geq \hat{w}_{AL}(w_S, w_L)$ ; and (ii) as just discussed, no equilibrium exists in the boundary case  $v_{AL} = v_S$ .

## D Proof of Proposition 3

*Stackelberg leadership.* Suppose that  $L$  benefits from a first-mover advantage: it sets its prices first, and then, having observed these prices,  $S$  sets its own price. Retail prices are often strategic complements, and it is indeed the case here for  $S$  in the  $B$  segment: as noted before,  $S$ 's best response,  $\hat{r}_S(r_L)$ , increases with  $r_L$ . Thus, in the case of "normal competition" in the  $B$  market,  $L$  would exploit its first-mover advantage by *increasing* its price for  $B_L$ , so as to encourage its rival to increase its own price and relax the competitive pressure. In contrast, here  $L$  has an incentive to *decrease*  $r_L$  even further. This leads  $S$  to decrease its own price, which allows  $L$  to raise the price for  $A$ . To see this, note that  $L$ 's Stackelberg profit from a loss-leading strategy can be written as:

$$\Pi_L^S(r_L) = \Pi_{AL}^m - r_L F(\hat{\tau}(r_L)) = \Pi_{AL}^m - r_L F(w_S - w_L + r_L - \hat{r}_S(r_L)).$$

Denoting by  $r_L^S$  the optimal Stackelberg margin and using  $\hat{r}_S(\hat{r}_L^*) = \hat{r}_S^*$ , where  $\hat{r}_L^*$  and  $\hat{r}_S^*$  are the equilibrium margins when  $L$  moves simultaneously with  $S$ , we have:

$$\begin{aligned} -r_L^S F(w_S - w_L + r_L^S - \hat{r}_S(r_L^S)) &\geq -\hat{r}_L^* F(w_S - w_L + \hat{r}_L^* - \hat{r}_S(\hat{r}_L^*)) \\ &\geq -r_L^S F(w_S - w_L + r_L^S - \hat{r}_S^*), \end{aligned}$$

where the second inequality stems from the fact that  $\hat{r}_L^*$  constitutes  $L$ 's best response to  $r_S^*$ . Since  $-r_L^S > 0$  and  $F(\cdot)$  and  $\hat{r}_S(\cdot)$  are both increasing, this in turn implies  $r_L^S \leq \hat{r}_L^*$ . This inequality is moreover strict, since (using  $\hat{\tau}(\hat{r}_L^*) = \hat{\tau}^*$ ):

$$(\Pi_L^S)'(\hat{r}_L^*) = -F(\hat{\tau}^*) - \hat{r}_L^* f(\hat{\tau}^*) (1 - \hat{r}_S'(\hat{r}_L^*)) = \hat{r}_L^* f(\hat{\tau}^*) \hat{r}_S'(\hat{r}_L^*) < 0.$$

Thus,  $L$  sells the competitive product  $B_L$  further below-cost, compared with what it would do in the absence of a first-mover advantage:  $r_L^S < \hat{r}_L^*$ .

*Entry accommodation.* Suppose now that the presence of  $S$  is uncertain. To capture this possibility, assume that  $S$  incurs a fixed cost for entering the market,  $\gamma$ , which is ex ante distributed according to a cumulative distribution function  $F_\gamma(\cdot)$ , and consider the following timing:

- In stage 1,  $L$  chooses its prices.
- In stage 2, the entry cost is realized, and  $S$  chooses whether to enter; if it enters, it then sets its own price.

If entry were certain, maximizing its Stackelberg profit would lead  $L$  to adopt  $r_L^S$ . But now,  $S$  enters only when its best response profit,  $\hat{\Pi}_S(r_L)$ , exceeds the realized cost  $\gamma$ , which occurs with probability  $\rho(r_L) \equiv F_\gamma(\hat{\Pi}_S(r_L))$ .  $L$ 's ex ante profit is therefore equal to

$$\hat{\Pi}_L^S(r_L) = \Pi_{AL}^m + \rho(r_L) \Pi_L^S(r_L).$$

The optimal margin,  $\hat{r}_L^S$ , thus satisfies

$$\rho(\hat{r}_L^S) \Pi_L^S(\hat{r}_L^S) \geq \rho(r_L^S) \Pi_L^S(r_L^S) \geq \rho(r_L^S) \Pi_L^S(\hat{r}_L^S),$$

which implies

$$\rho(\hat{r}_L^S) \geq \rho(r_L^S).$$

Since  $F_\gamma$  and  $\hat{\Pi}_S$  are both increasing in  $r_L$ , so is  $\rho$  and thus  $\hat{r}_L^S \geq r_L^S$ . This inequality is moreover strict, since

$$\left(\hat{\Pi}_L^S\right)'(r_L^S) = \rho'(r_L^S) \Pi_L^S(r_L^S) + \rho(r_L^S) \left(\Pi_L^S\right)'(r_L^S) = \rho'(r_L^S) \Pi_L^S(r_L^S) > 0.$$

Therefore, when  $L$ 's comparative advantage leads it to adopt a loss-leading strategy, it limits the subsidy on  $B$  so as to increase the likelihood of entry:  $\hat{r}_L^S > r_L^S$ .

## E Proof of Proposition 4

In the equilibrium where  $L$  attracts one-stop shoppers in the absence of a ban,  $L$  must offer a higher value than  $S$ :  $v_{AL} = v_{AL}^m > \hat{v}_S^* = w_S - \hat{r}_S^*$ , and  $S$  must moreover not be tempted to deviate and attract one-stop shoppers, which boils down to  $\hat{\Pi}_S^* = h(\hat{r}^*) F(\hat{r}^*) \geq \hat{\Pi}_S^d =$

$(w_S - v_{AL}^m) F(v_{AL}^m)$ . If  $L$  keeps attracting one-stop shoppers (i.e.,  $v_{AL} > v_S$ ) when loss leading is banned, then the unique candidate equilibrium is  $r_{AL} = r_{AL}^m$ ,  $r_L = 0$  and  $\hat{r}_S^b = h(\tau^*)$ , where  $\tau^* = l^{-1}(w_S - w_L)$ .

We show now this candidate equilibrium prevails when loss-leading would arise if below-cost pricing were allowed. Note that, since  $S$  increases its price (i.e.,  $\hat{r}_S^b = h(\tau^*) > \hat{r}_S^* = h(\hat{\tau}^*)$ ), it offers less value ( $v_S = \hat{v}_S^b \equiv w_S - \hat{r}_S^b < \hat{v}_S^*$ ), and thus  $L$  indeed attracts one-stop shoppers:  $v_{AL} = v_{AL}^m > (\hat{v}_S^* >) \hat{v}_S^b$ . Furthermore, as  $S$  must again offer at least  $v_S = v_{AL}$  to attract one-stop shoppers, it still cannot obtain more than  $\hat{\Pi}_S^d$  by deviating in this way. Therefore, since  $S$  now obtains more profit ( $\Pi_S^* \equiv h(\tau^*) F(\tau^*) > \hat{\Pi}_S^* = h(\hat{\tau}^*) F(\hat{\tau}^*)$ ), it is less tempted to deviate:  $\Pi_S^* > (\hat{\Pi}_S^* >) \hat{\Pi}_S^d$ . It follows that the conditions for sustaining the above equilibrium are less stringent than that for the loss-leading equilibrium.

## F Proof of Proposition 5

We focus on the large retailer's strategies, taking the strategies of the smaller retailer(s) as given; thus, whether the smaller rival is a strategic player or a competitive fringe does not matter here.

$L$ 's profit can be written as (see Figure 1):

$$\Pi_L = r_{AL}D_{AL} + r_A D_{AS} = r_{AL} \int_{\tau}^{v_{AL}} G(x_{AL}(t)) f(t) dt + r_A \int_0^{\tau} G(x_A(t)) f(t) dt.$$

To characterize the equilibrium values of  $r_L$  and  $r_{AL}$ , we now consider the impact of a small change on either variable.

Consider first a modification of  $r_A$  by  $dr$ , adjusting  $r_L$  by  $-dr$  so as to keep  $r_{AL}$  constant. Such a change does not affect the behavior of one-stop shoppers (it has no impact on  $v_{AL}$  and  $x_{AL}(t)$ ), but (see Figure 1):

- It affects multi-shop shoppers: for  $t < \tau$ , the marginal consumer indifferent between buying  $A$  from  $L$  or patronizing  $S$  only becomes  $x = x_A(t) - \sigma dr$ ; therefore,  $L$  loses  $\sigma g(x_A(t)) dr$  consumers, on which it no longer earns the margin  $r_A$ .  $L$  however increases its margin by  $dr$  on the mass  $G(x_A(t))$  of consumers that buy  $A$ . Thus, the overall impact of such an adjustment on multi-stop shoppers is equal to

$$\int_0^{\tau} [G(x_A(t)) - \sigma r_A g(x_A(t))] f(t) dt dr.$$

- In addition, it alters the choice between one-stop and multi-stop shopping: those consumers for which  $t \in [\tau - dr, \tau]$  and  $x \leq x_A(t)$  turn to one-stop shopping and now buy  $B$  as well as  $A$  from  $L_1$ , which (noting that  $x_A(\tau) = \hat{x}$ ) brings a gain  $r_L G(\hat{x}) f(\tau) dr$ .



These effects must cancel out in equilibrium, which yields

$$\int_0^\tau [\sigma r_A - k(x_A(t))] g(x_A(t)) f(t) dt = r_L G(\hat{x}) f(\tau).$$

Likewise, adjusting slightly  $r_{AL}$  by  $dr$ , keeping  $r_A$  constant (and thus changing  $r_L$  by  $dr$  as well) does not affect the behavior of multi-stop shoppers (it has no impact on  $v_{AS}$  and  $x_A(t)$ ), but:

- It affects one-stop shoppers: for  $t > \tau$ , the marginal shopper becomes  $x = x_{AL}(t) - \sigma dr$ , and the resulting change in profit is

$$\int_\tau^{v_{AL}} [G(x_{AL}(t)) - \sigma r_{AL} g(x_{AL}(t))] f(t) dt dr.$$

- In addition, those consumers for which  $t \in [\tau, \tau + dr]$  and  $x \leq x_{AL}(t)$  become multi-stop shoppers and stop buying  $B$  from  $L$ , which (noting that  $x_{AL}(\tau) = \hat{x}$ ) brings a net effect  $-r_L G(\hat{x}) f(\tau) dr$ .

In equilibrium, these effects must again cancel each other, which yields

$$\int_\tau^{v_{AL}} [\sigma r_{AL} - k(x_{AL}(t))] g(x_{AL}(t)) f(t) dt = -r_L G(\hat{x}) f(\tau).$$

Therefore, if in equilibrium  $r_L$  were non-negative, we would have

$$\int_0^\tau [\sigma r_A - k(x_A(t))] g(x_A(t)) f(t) dt \geq 0 \geq \int_\tau^{v_{AL}} [\sigma r_{AL} - k(x_{AL}(t))] g(x_{AL}(t)) f(t) dt,$$

that is,  $r_A$  would exceed a weighted average of  $k(x_A(t))/\sigma$  for  $t \in [0, \tau]$ , whereas  $r_{AL}$  would be lower than a weighted average of  $k(x_{AL}(t))/\sigma$  for  $t \in [\tau, v_{AL}]$ . But since  $k(x_A(t))$  and  $k(x_{AL}(t))$  decrease as  $t$  increases ( $k(\cdot)$  increases by assumption, and both  $x_A(t)$  and  $x_{AL}(t)$  decrease by construction), this would imply  $r_A > r_{AL}$ , a contradiction. Therefore, in equilibrium,  $r_L < 0$ .

If the shopping cost  $t$  is distributed over some interval  $[0, T]$ , where  $T > \tau$  to ensure that large retailers still attract some one-stop shoppers, the first-order conditions become:

$$\begin{aligned} \int_0^\tau [\sigma r_A - k(x_A(t))] g(x_A(t)) f(t) dt &= r_L G(\hat{x}) f(\tau), \\ \int_\tau^{\min\{v_{AL}, T\}} [\sigma r_{AL} - k(x_{AL}(t))] g(x_{AL}(t)) f(t) dt &= -r_L G(\hat{x}) f(\tau); \end{aligned}$$

it thus suffices to replace  $v_{AL}$  with  $\min\{v_{AL}, T\}$  in the above reasoning.

## G Proof of Proposition 6

Consider first (symmetric) equilibria of type  $M$ , in which large retailers compete only for multi-stop shoppers. In the absence of any bound on shopping costs, the demands for assortments  $A_1L_1$  and  $A_1S$  in such equilibrium, where  $r_{A_1L_1} = r_{A_2L_2} = r_{AL}$  and  $r_{L_1} = r_{L_2} = r_L$  (and thus  $r_{A_1} = r_{A_2} = r_A$ ), can be expressed as:

$$D_{AS} = \int_0^\tau G(\hat{x}_A(t)) f(t) dt \text{ and } D_{AL} = \int_\tau^{v_{AL}} G(x_{AL}(t)) f(t) dt,$$

where as before  $\tau = v_S - v_L$  and  $x_{AL}(t) = \sigma(v_{AL} - \max\{t, v_S\})$ , and  $\hat{x}_A(t) \equiv \sigma(v_A - \max\{t, \hat{v}_A\}) = \min\{1/2, x_A(t) = \sigma(v_A - t)\}$ .

Applying the same approach as above, starting from a candidate symmetric equilibrium, consider first a small change  $dr$  in  $r_{A_1}$ , adjusting  $r_{L_1}$  by  $-dr$  so as to keep  $r_{A_1L_1}$  constant:

- For  $t < \hat{v}_A$ , the marginal consumer who is indifferent between buying  $A$  from  $L_1$  or  $L_2$  is such that:

$$w_A - (r_A + dr) - \frac{x}{\sigma} = w_A - r_A - \frac{1-x}{\sigma},$$

or:

$$x = \frac{1}{2} - \frac{\sigma dr}{2}.$$

The overall impact on  $L_1$ 's profit is thus:

$$\int_0^{\hat{v}_A} [G(\hat{x}_A(t)) - \frac{\sigma}{2} r_{Ag}(\hat{x}_A(t))] f(t) dt dr.$$

- For  $\hat{v}_A < t < \tau$ , the marginal consumer indifferent between buying  $A$  from  $L_1$  or patronizing  $S$  becomes  $x = x_A(t) - \sigma dr$ , and the resulting impact on profit is:

$$\int_{\hat{v}_A}^\tau [G(\hat{x}_A(t)) - \sigma r_{Ag}(\hat{x}_A(t))] f(t) dt dr.$$

- In addition, those consumers for which  $t \in [\tau - dr, \tau]$  and  $x \leq \hat{x}_A(t)$  turn to one-stop shopping and now buy  $B$  as well as  $A$  from  $L_1$ , which brings a additional profit  $r_L G(\hat{x}) f(\tau) dr$ .

Therefore, in equilibrium, we must have:

$$\int_0^\tau [\sigma r_A - \eta_A(t)] \hat{g}(\hat{x}_A(t)) f(t) dt = r_L G(\hat{x}) f(\tau), \quad (16)$$

where (using  $\hat{x}_A(t) = 1/2$  for  $t \leq \hat{v}_A$ ):

$$\eta_A(t) \equiv \begin{cases} 2k(\hat{x}_A(t)) & \text{for } t < \hat{v}_A \\ k(\hat{x}_A(t)) & \text{for } t > \hat{v}_A \end{cases} \quad \text{and } \hat{g}(x) \equiv \begin{cases} \frac{g(1/2)}{2} & \text{for } x = \frac{1}{2} \\ g(x) & \text{for } x < \frac{1}{2} \end{cases}.$$

Consider now a small change  $dr$  in  $r_{A_1L_1}$ , keeping  $r_{A_1}$  constant (and thus adjusting  $r_{L_1}$  by  $dr$  as well):

- for  $t > \tau$ , the marginal (one-stop) shopper becomes  $x = x_{AL}(t) - \sigma dr$  and the impact on the profit is

$$\int_{\tau}^{v_{AL}} [G(x_{AL}(t)) - \sigma r_{AL} g(x_{AL}(t))] f(t) dt dr;$$

- in addition, those consumers for which  $t \in [\tau, \tau + dr]$  and  $x \leq x_{AL}(t)$  become multi-stop shoppers and stop buying  $B$  from  $L_1$ , which brings a net loss  $-r_L G(\hat{x}) f(\tau) dr$ .

In equilibrium, we must therefore have

$$\int_{\tau}^{v_{AL}} [\sigma r_{AL} - \eta_{AL}(t)] g(x_{AL}(t)) f(t) dt = -r_L G(\hat{x}) f(\tau), \quad (17)$$

where  $\eta_{AL}(t) \equiv k(x_{AL}(t))$ .

Thus, if  $r_L$  were non-negative, the two conditions (16) and (17) would imply

$$\int_0^{\tau} [\sigma r_A - \eta_A(t)] \hat{g}(\hat{x}_A(t)) f(t) dt \geq 0 \geq \int_{\tau}^{v_{AL}} [\sigma r_{AL} - \eta_{AL}(t)] g(x_{AL}(t)) f(t) dt,$$

where  $\eta_A$  and  $\eta_{AL}$  decrease as  $t$  increases, and coincide for  $t = \tau$ ; this, in turn, would imply  $r_A > r_{AL}$ , a contradiction. A similar argument applies when the shopping cost  $t$  is distributed over some interval  $[0, T]$ .

The same approach can be used for (symmetric) equilibria of type  $O$ , in which large retailers compete as well for one-stop shoppers. In the absence of any bound on shopping costs, the demands for assortments  $A_1L_1$  and  $A_1S$  in such equilibrium can be expressed as

$$D_{AS} = \int_0^{\tau} G\left(\frac{1}{2}\right) f(t) dt \text{ and } D_{AL} = \int_{\tau}^{v_{AL}} G(\hat{x}_{AL}(t)) f(t) dt,$$

where  $\hat{x}_{AL}(t) \equiv \sigma(v_A - \max\{t, \hat{v}_{AL}\}) = \min\{1/2, x_{AL}(t) = \sigma(v_{AL} - t)\}$ .

Following a small change  $dr$  in  $r_{A_1}$ , adjusting  $r_{L_1}$  by  $-dr$  so as to keep  $r_{A_1L_1}$  constant, we have:

- for  $t < \tau$ , the marginal consumer indifferent between buying  $A$  from  $L_1$  or  $L_2$  becomes  $1/2 - \sigma dr/2$ ;
- in addition, those consumers for which  $t \in [\tau - dr, \tau]$  and  $x \leq \hat{x}_A(t)$  become one-stop shoppers.

Therefore, in equilibrium we must have

$$\int_0^\tau [\sigma r_A - \hat{\eta}_A] \hat{g}\left(\frac{1}{2}\right) f(t) dt = r_L G\left(\frac{1}{2}\right) f(\tau),$$

where  $\hat{\eta}_A \equiv 2k(1/2)$  and  $\hat{g}(1/2) = g(1/2)/2$ .

Likewise, following a small change  $dr$  in  $r_{A_1 L_1}$ , keeping  $r_{A_1}$  constant (and thus changing  $r_{L_1}$  by  $dr$  as well), we have:

- for  $\tau < t < \hat{v}_{AL}$ , the marginal (one-stop) shopper becomes  $x = x_{AL}(t) - \sigma dr/2$ ;
- for  $\hat{v}_{AL} < t < v_{AL}$ , the marginal (one-stop) shopper becomes  $x = x_{AL}(t) - \sigma dr$ ;
- in addition, those consumers for which  $t \in [\tau, \tau + dr]$  and  $x \leq \hat{x}_{AL}(t)$  become multi-stop shoppers: they stop buying  $B$  from  $L_1$ .

We must therefore have

$$\int_\tau^{v_{AL}} [\sigma r_{AL} - \hat{\eta}_{AL}(t)] \hat{g}(\hat{x}_{AL}(t)) f(t) dt = -r_L G(\hat{x}) f(\tau),$$

where

$$\hat{\eta}_{AL}(t) \equiv \begin{cases} 2k(\hat{x}_{AL}(t)) & \text{for } t < \hat{v}_{AL} \\ k(\hat{x}_{AL}(t)) & \text{for } t > \hat{v}_{AL} \end{cases},$$

and  $\hat{g}(x)$  is defined above with  $\hat{x}_{AL}(t) = 1/2$  for  $\tau \leq t \leq \hat{v}_{AL}$ . Thus, if  $r_L$  were non-negative, the above two conditions would imply:

$$\int_0^\tau [\sigma r_A - \hat{\eta}_A] \hat{g}\left(\frac{1}{2}\right) f(t) dt \geq 0 \geq \int_\tau^{v_{AL}} [\sigma r_{AL} - \hat{\eta}_{AL}(t)] \hat{g}(\hat{x}_{AL}(t)) f(t) dt,$$

and a contradiction follows, since  $\hat{x}_{AL}(t) \leq 1/2$ , with a strict inequality for  $t > \hat{v}_{AL}$ , and thus  $\hat{\eta}_{AL}(t) \leq 2k(\hat{x}_{AL}(t)) \leq \hat{\eta}_A$ , with again a strict inequality for  $t > \hat{v}_{AL}$ . A similar argument applies again when the shopping cost  $t$  is distributed over some interval  $[0, T]$ .<sup>46</sup>

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<sup>46</sup>That is, loss leading arises as long as the aggregate demand is elastic; if instead  $T < \hat{v}_{AL}$ , then all consumers buy both goods, in which case  $\hat{\eta}_{AL}(\cdot) = \hat{\eta}_A$  and  $\hat{g}(\hat{x}_{AL}(t)) = \hat{g}(1/2)$ , and  $r_L = 0$ .

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