Loss Leading as an Exploitative Practice*

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September 20, 2009

(Preliminary version, Please don't circulate)

Abstract

Loss Leading pricing is often referred to as an advertising strategy which allows retailers to attract consumers by subsidizing some products and make profits from other items; in this way, below-cost pricing may improve consumer welfare by compensating consumers for their lack of information. This paper shows that large retailers can instead use loss leading as an exploitative device at the detriment of smaller retailers, without any efficiency justification in terms of distribution cost or advertising. We show further that banning below-cost pricing can unambiguously increase consumer surplus and social welfare as well as smaller retailers' profit.

*Zhijun Chen is grateful to the Economic and Social Research Council, UK for financial support.

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1 Introduction

The last three decades have seen the emergence of large retailers known as supermarkets, like Wal-Mart and Carrefour, which provide a full line of groceries and allow consumers to fill their baskets in one-stop shopping. Retailing market has displayed a trend towards much higher concentration due to the quick expanse of larger retailers, and the ever-growing market power of large retailers has caused serious concerns on detrimental impacts against small retailers such as discount stores, specialist grocery retailers and convenience stores.[1]

One particular concern is caused by a below-cost pricing strategy which is commonly adopted by multiproduct retailers and known as loss leading.[2] The practice consists in pricing some "leader" products below cost to attract customers to the retail outlet, in order to make profit on other items sold therein. Loss leading has not been frequently studied in economic theory and is subject to conflicting views in practice. In the famous case of *American Drugs vs. Wal-Mart Stores (1993)*, for example, Wal-Mart was sued under Arkansas' *Unfair Practice Act* for below-cost pricing on certain pharmaceuticals, by which the Court found that intent to injure competitors and destroy competition could be inferred from circumstances such as the number and extent of below cost sales. Wal-Mart lost the initial trial, but won on appeal in the Supreme Court of Arkansas, which stated 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 all together."[3] In another case of *Star Fuel Marts v. Murphy Oil (2003),* however, 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 which sells groceries in a wholesale club format. The court ruled that pricing below cost is prima facie evidence of intent to harm competitors and also of a tendency to dampen competition.[4]

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[1] See for example the reports of the US Federal Trade Commission (2001, 2003) – as well as the FTC conference held on May 24, 2007, http://www.ftc.gov/be/grocery/index.shtm – or the groceries market enquiries of the UK Competition Commission (2000, 2008) recommending codes of practices. In France, the concerns associated with the large retailers market power triggered the adoption of two Acts in 1996, respectively aimed at curbing their expansion and the exploitation of their market power; and a series of new laws and regulations have again been put in place over the last three years.

[2] In its recent report on the grocery market, the UK Competition Commission notes for example that most large retailers were engaged in below-cost selling, concentrated in two to three product lines but representing up to 3% of a retailer's total revenue. See Competition Commission (2008) at p. 94.

[3] See Boudreaux (1996) for details.

[4] Star Fuel Marts, LLC. v. Murphy Oil, Inc., No. CIV-02-2002-F (W.D. Okla.2003) (order granting preliminary

A similar discrepancy appears in the differential treatment of below-cost retail pricing in European national laws. Restrictions on below-cost selling are indeed legislated in Belgium, France, Ireland, Portugal and Spain, but not in Denmark, Germany, or Italy, although below-cost pricing has been intervened in some cases in these countries.[5]

While lawyers and practitioners for the most part are ill equipped to evaluate loss leading and tend to shoe horn it into existing frameworks on evaluating predatory pricing,[6] however in most cases such evaluating fails to establish recoupment and the feasibility of predation. In its recent report, the UK Competition Commission concludes for example "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."[7] Moreover there is no solid economic analysis that refers loss leading to predatory pricing. Loss leading pricing is instead related to the optimal pricing strategy of a multiproduct monopolist who can benefit from cross-subsidizing products with different elasticities;[8] it is also referred to as featuring or advertising strategy,[9] which would suggest that below-cost pricing may compensate consumers for their imperfect information and may improve consumer surplus.[10]

This paper finds that a large retailer can use loss leading as an exploitative device, at the detriment of a smaller retailer. We show that in equilibrium the large retailer can engage in loss leading so as to extract rents from the smaller but more efficient rival, and makes even more profit than in the absence of the rival.

More precisely, we consider a simple setting where a large retailer has a monopoly over some products, but faces competition from a more efficient small retailer on other products. We also

injunction).

[5] For instance, in 2000 the German Cartel Office ordered Wal Mart, Aldi and Lidl to stop selling below cost staples such as milk or butter, as this could impair competition and force smaller retailers out of the market.

[6] See for instance Bolton, Brodley and Riordan (2000) and Eckert and West (2003) for detailed discussion.

[7] See Competition Commission (2008), Page.98. Applying predatory pricing tests would often require that the practice not only harm smaller retailers, but also the large retailer would have sufficient market power afterwards to recoup the losses incurred during the predation phase. The Competition Commision finds that both conditions are unlikely to be met in the case of loss leading practices.

[8] See Bliss (1988).

[9] Lal and Matutes (1994) indicates that the interaction between uninformed rational consumers and multiproduct competition can lead to an equilibrium where firms advertise loss leaders to compete for store traffic.

[10] 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 the laissez faire full information scenario and therefore price intervention is not justified.

account for heterogenous consumers' shopping costs in which more time-constrained consumers prefer one-stop shopping. In order to ignore the cross-subsidizing and advertising effects of the loss leading that have already been discussed in the literature, we focus on situations in which consumers are homogenous in their valuations of the goods and are fully informed about all prices. With these setups, we find that the large retailer could still attract one-stop shoppers, who have relatively high shopping costs and thus prefer to buy the full range of products from the same store, with prices that, overall, remain at the monopolistic level that it could charge absent the rival. However, reducing the prices of competitive products below costs exerts a competitive pressure on the rival, and this benefits cherry-pickers who, facing lower shopping costs, buy the non-competitive products from the large retailer and the competitive products from the lower-price small retailer. Keeping constant the overall price for the whole assortment to the monopolistic level, it then allows the large retailer to increase the prices for the noncompetitive products above the level of the monopolistic prices for the whole assortment, so as to extract extra rents from cherry-pickers who only buy noncompetitive products from the large retailer, and in this way the large retailer makes even more profit than in the absence of the rival.

Intuitively, loss leading is indeed a form of price discrimination which allows the large retailer to discriminate two types of consumers and earn even higher profit from cherry-pickers who buy only non-competitive products from the large retailer, than one-stop shoppers who purchase both the competitive and non-competitive products, therefore it is equivalent to a bundled discount for one-stop shoppers.

While loss leading increases the large retailer's profit, this is achieved at the expense of the rival retailer. Since the large retailer can make more profit in this way than in the absence of the rival, it is clearly optimal for it to accommodate rather than to foreclose the more efficient small retailer. Our findings suggest that loss leading is an exploitative device rather than a predation practice;[11] attempts to shoe horn their analysis into traditional thinking about the predatory pricing may be misguided. Our finding also suggest that merely observing the smaller retailer has positive sales in the marketplace is not sufficient to conclude that the large retailer's loss leading strategy is innocuous, even if there is no evidence that the smaller retailer's long-run

[11] Marx and Shaffer (1999) label such a below-cost pricing practice as predatory accommodation without exclusion. Using the setting of rent-shifting a la Aghion-Bolton (1987), they show that below-cost pricing can arise in intermediate goods markets when a monopolist retailer negotiates sequentially with two suppliers of substitute products, and below-cost pricing by one supplier allows the retailer to extract rents from the second supplier. However, they show that the welfare effects of such a below-cost pricing is ambiguous and could be pro-competitive under some conditions.

viability is threatened. Rather, we find that prices to consumers would still be higher, welfare would still be lower, and the smaller retailer would still be worse off than they would have been without the use of loss leading. Our findings therefore support the intervention against loss leading in this circumstance.[12]

While we establish the basic insights under the assumptions that consumers have heterogenous preferences, we show that loss leading as rent extraction can still arise in equilibrium when consumers have heterogenous preferences over competitive products or non-competitive goods.

This paper is closely related to the small literature on competitive pricing of multi-product firms in the presence of consumer shopping cost. Amstrong and Vickers (2009) provide a generalized framework in which consumers have heterogeneous and elastic demands and have to incur additional shopping cost in accessing the second supplier, and examine the equilibrium competitive non-linear pricing of two multi-product firms; in contrast, we analyze the price competition between a multi-product firm and a single-product firm, with a focus on the anticompetitive effect of below-cost pricing. They show that in equilibrium firms can make more profit by offering a menu of efficient two-part tariffs including bundled discount than linear pricing; while we show that loss leading is indeed a form of price discrimination and is equivalent to a bundled discount.

The paper contributes to the literature of loss leading pricing. In a model where uninformed rational consumers must decide where to buy each product, Lal and Matutes (1994) show that loss leading can arise in an equilibrium where firms advertise the price of some good below marginal cost to attract consumers, and then profit from sales of other goods. The study of loss leading as an advertising strategy to attract consumers imperfectly informed about prices is also incorporated with the growing literature on search and price dispersion since the seminal paper by Varian (1980).

While most of the literature on loss leading pricing assumes that consumers are either bounded rationality or are subject to imperfect information on prices, and focuses on the effect of the revelation of information on prices through loss leading, whether loss leading pricing can be successful when consumers are fully rational and fully informed about prices is not well analyzed. In a model of monopolistic competition with fully informed buyers, Bliss (1988) indicates that

[12] This result is in contrast with the finding by Allain and Chambolle (2005) who argue that manufactures can take advatange of the law of banning loss leading, to maintain higher retail price and make more profits, therefore banning pricing below cost may cause a perverse effect on consumer welfare.

the possibility of some price being set below marginal cost cannot be excluded when consumers have different demand elasticities since the monopolistic firm can set different prices for different goods to cross-subsidize, however Bliss (1988) leaves the characterization of conditions under which loss leading can arise in equilibrium as an open question. Recently in a model of oligopoly competition between multiproduct firms, Ambrus and Weinstein (2008) shows that when demands are inelastic and consumers are fully informed about prices, loss leading cannot occur in equilibria. They further show that equilibrium loss leading can occur if there are demand complementarity, but only with delicate relationships among the preferences of all consumers, which is far from the general case.

This paper however finds that loss leading can arise in equilibrium when consumers are fully informed about prices, as a facilitation of rent extraction without the justification of efficiency gains from the advertising effect, in a setting where a large retailer competes with a smaller but more efficient rival.

This paper also contributes to the research of retailer market power. Large retailers exert market power in two layers:[13] First, large retailers are able to exercise buyer power against weaker manufactures, through sophisticated contract arrangements and practices including conditional purchase requirements, additional payment requirements as well as deliberate risk shifting, and thus reap extra profits from suppliers;[14] this causes an adverse effect on the investment and innovation in the supply chain, and ultimately on consumers.[15] Second, the high retailer concentration allows the dominant retailer to exercise market power against small retailers, through buyer-driven vertical restraints, and exploit or even foreclose the rivals in order to monopolize in local markets.[16]

Yet, the existing literature on retailing power has mainly focused on the vertical layer, that

[13] See the excellent survey on retailer power by Dobson and Waterson (1999).

[14] For instance, Marx and Shaffer (2007) investigate the competitive effects of upfront payments such as slotting allowance claimed by the large retailers, and find that upfront payments are a feature of equilibrium contracts which lead to the exclusion of small retailers. While Miklos-Thal, Rey and Verge (2008) finds that conditional fixed fees and upfront payments can be used to internalize all contracting externalities and thus implement the monopoly outcome.

[15] For instance, Inderst and Shaffer (2007) shows that the concentration in the retail industry would cause the suppliers strategically to produce less differentiated products and reduce the product variety.

[16] Comanor and Rey (2000) shows that dominant distributors can employ vertical restraints to exclude price-cutting rivals, and their findings support the decision of FTC (1997) against the exclusive dealing practice employed by the Toys 'R' Us with its main suppliers, to deny its rivals with access to comparable products about which price comparison could be made.

is, the exercise of buyer power through vertical restraints; while has few studies on the exercise of seller power against smaller rivals. This paper shows how the large retailer can exert its seller power to exploit the smaller but more efficient rival through loss leading. Intuitively, large retailers offer more values than smaller rivals for consumers who prefer one-stop shopping, and can thus take this advantage to extract rents from the more efficient rivals through those consumers who have lower shopping cost and enjoy lower prices from multi-shopping. The basic setting can be further used as a building block to develop a framework for the study of interactions between two-layer retailer power, and this framework would allow us to investigate various vertical restraints led by retailers as well as other practices that generate high buyer power, and highlight the mechanics that transform the buyer power into the seller power.

The rest of the paper is organized as follows. We develop a simple model for retail competition between a large retailer and smaller retailer in the presence of consumer shopping costs in Section 2, and show in Section 3 that loss leading can arise in a unique equilibrium provided that the large retailer has sufficient competitive advantages. We provide further implications for competition policy in Section 4 and check the robustness of the basic setting in Section 5. Finally we conclude in Section 6.

2 The model

2.1 Market structure and consumer choice

Two retailers, labelled by 1 and 2, compete in a local retail market. Retailer 1 is a large retailer, for instance, the large retailer, which offers a broader range of products than retailer 2, a smaller retailer like discount store. For the sake of exposition, we will simply assume that there are two products, labelled by A and B. Product A is monopolized by retailer 1, while product B is offered by both retailers.[17] Retailer 1 incurs a marginal cost c_A for product A, as well as a marginal cost c_1 for product B. Retailer 2 is more efficient in distributing product B and has a lower marginal cost $c_2 < c_1$; let $\gamma \equiv c_1 - c_2$ denote its cost-advantage.

Each consumer obtains a utility u_A or u_B when buying product A or B respectively, while obtains a utility $u_{AB} \leq u_A + u_B$ when consuming both products.[18] We first assume that all

[17] The products A and B could alternatively be interpreted as reflecting different varieties of the same product line, which may be partially substitute. We extend the model in this direction in section ??.

[18] This setting then includes the cases of independent products where $u_{AB} = u_A + u_B$, and partial substitute products where $u_{AB} < u_A + u_B$.

consumers have the same valuations for good A and B, as well as the bundle of two products, but will also consider later on the case where consumers have heterogeneous preferences over these products. Each consumer wishes to buy one unit of each product, and we assume that $u_A > c_A$ and $u_B > c_2$, so that it is socially desirable to supply both products. Visiting a store costs one unit of time to consumers, including the time for traffic, parking, as well as selecting and checking out. The perceived cost of this shopping time, denoted by t, varies across persons and is characterized by a cumulative distribution function $G(\cdot)$, with a density function $g(\cdot)$ and a hazard rate $h(\cdot) \equiv G(\cdot)/g(\cdot)$ which is assumed to be strictly increasing.

The assumption that consumers have the same preferences allows us to disentangle the effect of cross subsidizing between products with different demand elasticities that would lead to loss leading as an optimal pricing strategy as argued by Bliss (1988); we show in the supplementary appendix that the analyses are robust when consumers have heterogeneous preferences over product A or B.

Consumers choose retailers based on the considerations of (1) the value of assortments, (2) prices, and (3) transactional conveniences relating to shopping time. The assumptions on heterogeneous shopping costs reflect the facts that visiting several stores incurs multiple shopping costs, and the value of time varies across persons, with some consumers less time-constrained than others. Our framework shares in this way the same logic as Armstrong and Vickers (2009) in which consumers incur additional shopping cost for approaching the second firm, and the shopping cost can also vary across consumers.

Retailer 1 and 2 simultaneously set their prices, (p_A, p_1) and p_2 respectively.[19] Consumers observe all prices and then make decisions on shopping. No shopping brings a reservation utility 0; instead a consumer wants to go shopping faces four relevant options: (1) buy both products from retailer 1; (2) buy only product A from retailer 1; (3) buy only product B from retailer 2; and (4) buy product A from retailer 1 and product B from retailer 2.[20]

A consumer who purchases both products from the large retailer obtains a value $v_{A1} \equiv u_{AB} - p_A - p_1$, and the consumer is willing to do so only if this value exceeds the shopping cost t, that is, if $t \leq v_{A1}$. By analogy, a consumer will buy product A only from retailer 1 if $t \leq v_A \equiv u_A - p_A$, and will buy product B from retailer 2 only if $t \leq v_2 \equiv u_B - p_2$. Alternatively,

[19] We consider linear and unbundled pricing here. We show later that the large retailer cannot benefit from pure or mixed bundling.

[20] We will see that retailer 2 always charges a price $p_2 \leq p_1$ in equilibrium; a consumer therefore never buys only good B from retailer 1.

a consumer can choose to buy good A from retailer 1 and good B from retailer 2 if $p_2 < p_1$, and this multi-shopping brings a value $v_{A2} \equiv u_{AB} - p_A - p_2$ at the expense of a double shopping cost $2t$, so it will happen only if $t \leq \frac{v_{A2}}{2}$.

To simplify exposition, we will use retail margins, denoted by $r_A \equiv p_A - c_A$, $r_1 \equiv p_1 - c_1$, and $r_2 \equiv p_2 - c_2$, rather than prices as strategic variables for the retailers. In addition, let $w_A \equiv u_A - c_A$, $w_1 \equiv u_B - c_1$, and $w_2 \equiv u_B - c_2$ denote the social welfare (gross of shopping costs) generated by the supply of products A and B by retailers 1 and 2 respectively, and let $w_{A1} \equiv u_{AB} - c_A - c_1$ denote the total welfare that the large retailer can bring. Finally, let $\Delta \equiv w_{A1} - w_2 = w_{A1} - w_1 - \gamma$ denote the competitive advantage of the large retailer. We are interested in the case where the large retailer dominates in the local market, and will therefore assume $w_{A1} - w_1 > w_2$, or $\gamma < w_{A1} - 2w_1$.[21]

Given the consumer values for different shopping plans, we can characterize the demand that the large retailer and the small retailer would face. Notice that retailer 1 attracts one-stop shoppers when it offers more values than its rival, that is, $v_{A1} \geq v_2$; in this case (denoted as regime S) retailer 2 can only attract cherry-pickers who buy product A from retailer 1 and product B from retailer 2 if $v_{A2} - 2t \geq v_{A1} - t$, that is, if the extra gain from multi-shopping offsets additional shopping cost:

$$t \leq \tau \equiv v_{A2} - v_{A1},$$

where τ represents the value of time that leaves the consumer indifferent between one-stop shopping and multi-shopping. In regime S, consumers are willing to visit the large retailer if $t \leq v_{A1}$, while they would rather visit both stores if $t \leq \tau$.[22] The large retailer thus attracts a demand $G(v_{A1}) - G(\tau)$ for both products from one-stop shoppers, and an additional demand $G(\tau)$ for product A from cherry-pickers; in contrast, the small retailer faces a demand $G(\tau)$ from cherry-pickers. So, in regime S, the large retailer makes a profit

$$\Pi_1 = r_{A1}\left(G(v_{A1}) - G(\tau)\right) + r_A G(\tau) = r_{A1} G(v_{A1}) - r_1 G(\tau),$$

where $r_{A1} \equiv r_A + r_1$ is the total retail margin, while the small retailer obtains a profit

$$\Pi_2 = r_2 G(\tau).$$

[21] This is in line with the observation that typical hard discounters, such as Aldi and Lidl in Europe, offer much fewer categories of groceries than large supermarkets, and less than 10% of total categories provided by the supermarket. See Cleeren, Verboven, Dekimpe and Gielens (2008) for detailed report.

[22] Notice that this regime includes the cases $\tau = 0$ (no cherry-picker) and $\tau = v_{A1}$ (no one-stop shopper).

If instead the small retailer could offer more value than the large retailer, that is, $v_2 > v_{A1}$, it could attract one-stop shoppers to purchase in its outlet. In this case (denoted as regime D), one-stop shoppers would be willing to purchase in the small retailer when $t \leq v_2$, while cherry-pickers would rather visit both stores when $t \leq v_A$ (where $v_A \leq v_{A1} < v_2$ in this regime). In regime D, the small retailer would then face a total demand $G(v_2)$ from both one-stop shoppers and cherry-pickers, and could thus earn a profit

$$\widehat{\Pi}_2 = r_2 G(v_2),$$

whereas the large retailer would face only a demand $G(v_A)$ for product A only from cherry-pickers, and make a profit

$$\widehat{\Pi}_1 = r_A G(v_A).$$

2.2 Benchmark: monopoly

As a benchmark, we consider the case where the large retailer is a monopolist for both products. If $u_B > c_1$, a consumer will buy both products as long as $t \leq v_{A1} = w_{A1} - r_{A1}$; the large retailer faces a demand $G(v_{A1})$ and thus makes a profit $r_{A1}G(v_{A1})$. The monopolistic total margin r_{A1}^m is then characterized by the first-order condition,[23] as given by

$$r_{A1}^m = h(v_{A1}). \tag{1}$$

Notice that $v_{A1} = w_{A1} - r_{A1} = w_{A1} - h(v_{A1})$, the consumer value under monopoly case can be written as

$$v_{A1}^m \equiv l^{-1}(w_{A1}), \tag{2}$$

where $l(x) \equiv x + h(x)$ is increasing in x, therefore the monopolistic profit of the large retailer is given by:

$$\Pi_1^m \equiv G(v_{A1}^m)h(v_{A1}^m).$$

If instead $u_B \leq c_1$, it is optimal not to supply product B. The large retailer then simply obtains a monopolistic profit on product A which, by the same logic, can be expressed as

$$\Pi_A^m \equiv G(v_A^m)h(v_A^m),$$

where $v_A^m \equiv l^{-1}(w_A) \geq l^{-1}(w_{A1}) = v_{A1}^m$.

[23] The profit function is strictly quasi-concave when the hazard rate $h(\cdot)$ is increasing, as proved in Appendix A.

3 Loss leading

We solve for the equilibria for regime S, under which the large retailer attracts one-stop shoppers when offering more value than the small retailer: $v_{A1} \geq v_2$. Differentiating $\Pi_2 = r_2 G(\tau)$ with respect to r_2, we can characterize the small retailer's best response by the first-order condition[24]

$$r_2 = h(\tau),$$

where $\tau = v_{A2} - v_{A1} = \gamma - (r_2 - r_1)$. Likewise, differentiating $\Pi_1 = r_{A1} G(v_{A1}) - r_1 G(\tau)$ with respect to r_{A1} and r_1 provide the first-order conditions for the best response of the large retailer:

$$\begin{aligned} r_{A1} &= h(v_{A1}), \\ r_1 &= -h(\tau). \end{aligned}$$

Since the first-order condition for the total margin r_{A1} coincides with (1), the large retailer still charges the monopolistic margin for the bundle of products; that is, the equilibrium margin is $r_{A1}^* = r_{A1}^m$. But the retail margin of the competitive product B is here negative: the large retailer adopts a loss leading strategy and prices product B below cost.

This can be understood as follows. Notice that all combinations of margins r_A and r_1 such that $r_A + r_1 = r_{A1}^*$ generate the same profit from one-stop shoppers, but yield different profit from cherry-pickers. Charging a price below-cost for product B (that is, $r_1 < 0$) actually allows the large retailer to increase the margin on the non-competitive product above the monopolistic level: the equilibrium margin satisfies $r_A^* = r_{A1}^* - r_1 > r_{A1}^m$; the large retailer therefore reaps a higher profit from the cherry-pickers, who only buy product A from the large retailer. The extra profit that the large retailer exploit from cherry-pickers is exactly $-r_1 G(\tau)$. Since decreasing r_1 further increases the retail margin but reduces the population of cherry-pickers, as τ decreases as a result, the optimal retail margin r_1 maximizes the rent $-r_1 G(\tau)$ and is given by the above first-order condition.

In this candidate equilibrium, the large retailer extracts an extra rents $-r_1 G(\tau) = G(\tau) h(\tau)$ from the small retailer by employing loss leading strategy. The equilibrium threshold of shopping cost below which consumers prefer multi-shopping, τ^*, is determined implicitly by the condition:

$$\tau = \gamma - (r_2 - r_1) = \gamma - 2h(\tau),$$

which yields

$$\tau^* \equiv j^{-1}(\gamma),$$

[24] Second-order conditions are checked in the Appendix A.

where $j(x) \equiv x + 2h(x)$ is strictly increasing. It follows that in equilibrium the small retailer earns a profit $\Pi_2^* \equiv G(\tau^*)h(\tau^*)$, while the large retailer obtains

$$\begin{aligned}\Pi_1^* &\equiv G(v_{A1}^*)h(v_{A1}^*) + G(\tau^*)h(\tau^*)\\ &= \Pi_1^m + G(\tau^*)h(\tau^*),\end{aligned}$$

which is higher than the monopolistic profit Π_1^m.

We now seek for conditions under which the above retail margins form indeed a Nash equilibrium. For this sake, two conditions must be satisfied: First, the large retailer must ensure that $v_{A1} \geq v_2$ in equilibrium in order to attract one-stop shoppers, which implies the large retailer must charge a retail margin r_{A1} lower than that of the small retailer r_2, taking moreover into account its competitive advantage Δ:

$$r_{A1} \leq r_2 + \Delta. \tag{3}$$

Second, since the large retailer earns a higher profit than the monopolistic level, it has no incentive to exclude the more efficient small retailer; whereas the small retailer may want to attract one-stop shoppers, by reducing its retail margin so that $r_2 \leq r_{A1} - \Delta$. In Appendix B, we show that in such undercutting (it is indeed a unilateral deviation), it is optimal for the small retailer to charge $r_2^d = r_{A1} - \Delta$, which brings a maximal profit from deviation equal to $\widehat{\Pi}_2^d = r_2^d G(v_2^d) = (r_{A1} - \Delta)\, G(v_{A1})$. It follows that the small retailer cannot benefit from such a deviation if the profit in the candidate equilibrium offsets the benefit from deviation: $\Pi_2 = r_2 G(\tau) \geq \widehat{\Pi}_2^d$. The equilibrium condition can be moreover written as

$$r_{A1} \leq r_2 \frac{G(\tau)}{G(v_{A1})} + \Delta, \tag{4}$$

which implies that, in the candidate equilibrium, the large retailer must charge a retail margin r_{A1} lower than the "weighted" retail margin of the small retailer, $r_2 \frac{G(\tau)}{G(v_{A1})}$, in addition to its competitive advantage Δ. Since $v_{A1} > \tau$, this equilibrium constraint is indeed more stringent than condition (3) under which the large retailer attracts one-stop shoppers, and is thus the only relevant constraint for equilibrium.

Substituting the equilibrium retail margins into this condition, we obtain:

$$\Delta G(v_{A1}^*) \geq G(v_{A1}^*)h\left(v_{A1}^*\right) - G(\tau^*)h(\tau^*), \tag{5}$$

which can be written as

$$\Psi(\gamma) \equiv \gamma - \frac{G(\tau^*)h(\tau^*)}{G(v_{A1}^*)} \leq w_{A1} - w_1 - h(v_{A1}^*), \tag{6}$$

where, as shown in Appendix B, $\Psi(\gamma)$ is increasing in γ. It follows that the optimal retail margins form a Nash equilibrium if[25]

$$\gamma \leq \gamma_1 \equiv \Psi^{-1}(w_{A1} - w_1 - h(v_{A1}^*)).$$

We now show that regime D, in which one-stop shoppers favor the small retailer, cannot arise in equilibrium when $\gamma \leq w_{A1} - 2w_1$. For the small retailer to attract one-stop shoppers, it must be the case that $v_2 > v_{A1}$, which requires that it must charge a retail margin lower enough such that

$$r_2 < r_{A1} - \Delta.$$

In regime D, the large retailer faces a demand for product A only from cherry-pickers $G(v_A)$ and thus makes a profit equal to $r_A G(v_A)$. Suppose now the large retailer wants to attract one-stop shoppers by undercutting the small retailer on product B, that is, reducing r_1(while keeping r_A and thus v_A as constant) such that $r_2 = r_{A1} - \Delta$ (and thus $v_2 = v_{A1}$), in which case it would still face a demand of product A from cherry-pickers, $G(\tau)$, but could attract an additional demand of both products from one-stop shoppers, $G(v_{A1}) - G(\tau)$. Notice that $\tau = v_A$ when $r_{A1} = r_2 + \Delta$, such an undercutting does not change the demand from cherry-pickers but brings a net gain from one-stop shoppers:

$$r_{A1}\left(G(v_{A1}) - G(\tau)\right) = (r_2 + \Delta)\left(G(v_2) - G(v_A)\right),$$

which is positive if $r_2 + \Delta > 0$. To discourage such undercutting strategies, the small retailer must lower its retail margin such that $r_2 + \Delta \leq 0$. But the small retailer would then earn a negative profit since $\Delta = w_{A1} - w_1 - \gamma > 0$, which cannot arise in equilibrium.

Therefore there exists a Nash equilibrium for regime S when $\gamma \leq \gamma_1$, and the equilibrium retail margins are characterized by the first-order conditions above, moreover, this equilibrium is unique when $\gamma \leq w_{A1} - 2w_1$. The above findings are summarized in the following proposition, which characterizes the unique Nash equilibrium:

Proposition 1 *When the small retailer's cost advantage is relatively small, namely, when $\gamma \leq \{\gamma_1, w_{A1} - 2w_1\}$, there exists a unique (pure strategy) Nash equilibrium in which the large retailer*

[25] Notice that the optimal retail margin for product A does not exceed w_A, which amounts to

$$r_A \leq r_2 - r_1 + \Delta = w_{A1} - w_1 - \tau < w_A.$$

adopts a loss-leading strategy: the large retailer offers the competitive product at a price below-cost, while keeping the total price for both products at the monopolistic level; as a result, the large retailer earns more profit than in the absence of the rival.

Proof. See Appendix B. ■

The intuition of rent-extraction can be further demonstrated. By employing loss leading pricing, the large retailer indeed exerts a competitive pressure on the small retailer, and in this way reduces the retail margin of the small retailer, which benefits the cherry-pickers who buy the competitive product from the small retailer. The large retailer can then recoup those extra gains by increasing the retail margin of the non-competitive product and thus make more profit from cherry-pickers who buy only the non-competitive good from the large retailer, without affecting the demand of one-stop shoppers (keeping the price for the bundle of both products unchanged). Therefore rent-extraction is accomplished by shifting the extra gain of a lower price for the competitive product, from the cherry-pickers to the large retailer.

It should be noted that this equilibrium involves an inefficient distribution of product B, since consumers whose shopping cost t lies between τ^* and γ are supplied by the large retailer at an extra cost γ, which could be avoided by encouraging them to buy from the small retailer at the expense of an additional shopping cost t. The large retailer may actually end up supplying product B even when doing so generates a negative social welfare, that is, when $u_B \leq c_1$, in which case a pure monopolist would then choose to sell only product A. The rent extracted through loss leading may compensate the loss from selling product B to one-stop shoppers, and this could happen when

$$\Pi_1^* = G(v_{A1}^m)h(v_{A1}^m) + G(\tau^*)h(\tau^*) > \Pi_A^m = G(v_A^m)h(v_A^m),$$

or

$$h(\tau^*)G(\tau^*) > G(v_A^m)h(v_A^m) - G(v_{A1}^m)h(v_{A1}^m),$$

which is indeed the case when u_B is slightly below c_1 (since v_{A1}^m coincides with v_A^m when $u_B = c_1$).

Tying and Bundled Discount

The loss leading strategy is indeed a form of price discrimination which allows the large retailer to charge different retail margins to different types of consumers, and obtain in this way from cherry-pickers a profit higher than the monopolistic level. This implies that bundling the two products is never optimal in this case, even if doing so can deter the entry of the efficient rival, since the large retailer cannot earn more than the monopolistic profit in case of exclusion.[26]

[26] Whinston (1990) shows that tying can be used as an exclusionary practice. By bundling the two products

The price discrimination between one-stop shoppers and cherry-pickers is indeed equivalent to a bundled discount which allows the one-stop shoppers to benefit from a price discount when they buy a bundle rather than only product A from the large retailer. To see this, suppose that, in addition to the stand-alone retail margins r_A and r_1, the large retailer offers a bundled discount x for both products, and thus reduces the retail margin for the bundle to $r^d_{A1} = r_A + r_1 - x$.[27] The bundled discount brings additional surplus to one-stop shoppers

$$v^d_{A1} = w_{A1} - r_{A1} = v_{A1} + x,$$

while does not change the surplus of cherry-pickers. Consequently, by offering the bundled discount, the large retailer can make a profit

$$\begin{aligned} \Pi_1 &= r^d_{A1}\left(G(v^d_{A1}) - G(\tau^d)\right) + r_A G(\tau^d) \\ &= r^d_{A1} G(v^d_{A1}) - (r_1 - x)\, G(\tau^d), \end{aligned}$$

where $\tau^d = v_{A2} - v_{A1} = \gamma + (r_1 - x) - r_2$; while and the small retailer still makes a profit

$$\Pi_2 = r_2 G(\tau^d).$$

Let $r^d_1 \equiv r_1 - x$ denote the virtual retail margin of product B that the large retailer could obtain under bundled discount, it follows immediately that the optimal margins are exactly the same as in the case absent bundled discount:

$$\begin{aligned} r^d_{A1} &= h(v^d_{A1}) = r^*_{A1}, \\ r^d_1 &= -h(\tau^d) = r^*_1, \\ r_2 &= h(\tau^d) = r^*_2, \end{aligned}$$

since the equilibrium price gap is the same as before: $\tau^d = j^{-1}(\gamma) = \tau^*$.[28]

The result is indeed quite intuitive. Since the large retailer cannot benefit from excluding the rival, it should encourage consumers with lower shopping cost to buy product B from the small retailer. Consumers could therefore buy from the large retailer either both products, or only product A; it follows that the only relevant retail margins for the large retailer are the total

together, an incumbent commits itself ex ante to be a tough competitor in case of entry in one market, thereby discouraging competitors from actually entering that market, and the incumbent then benefits from monopolizing both markets. In contrast, in our setting loss leading allows the supermarket to reap more profit in case of entry.

[27] Here the superscript d refers to the case when supermarket offers bundled discount.

[28] It appears obvious that conditions for sustaining the equilibrium are the same as before.

margin for the two products, r_{A1}, and the margin on product A sold on a stand-alone basis, r_A. Since $r_{A1} < r_A$, the large retailer indeed offers a bundled discount for the one-stop shoppers, as concluded in the following corollary:

Corollary 1 *Strategic tying is always dominated in this setting. While loss leading allows the large retailer to price-discriminate two types of consumers and is equivalent to a bundled discount for one-stop shoppers.*

Uniform Distribution: An Example

We give an example to demonstrate the analyses. Suppose that the shopping cost t is uniformly distributed over the real line, so that $G(x) = x$. The first-order conditions then boil down to

$$r_2 = \tau, \quad r_{A1} = v_{A1}, \text{ and } r_1 = -\tau.$$

Using $v_{A1} = w_{A1} - r_{A1}$ and $\tau = \gamma - (r_2 - r_1) = \gamma - 2\tau$, we obtain

$$v_{A1} = \frac{w_{A1}}{2} \text{ and } \tau = \frac{\gamma}{3},$$

thus the equilibrium margins are equal to

$$r_2^* = \frac{\gamma}{3}, \; r_1^* = -\frac{\gamma}{3}, \text{ and } r_{A1}^* = \frac{w_{A1}}{2}.$$

In equilibrium, the small retailer makes a profit

$$\Pi_2 = \tau^2 = \frac{\gamma^2}{9},$$

which is increasing in its cost advantage γ, whereas the large retailer obtains

$$\Pi_1 = v_{A1}^2 + \tau^2 = \frac{w_{A1}^2}{4} + \frac{\gamma^2}{9},$$

which is higher than the monopolistic level $\Pi_1^m = \frac{w_{A1}^2}{4}$. Moreover this equilibrium is sustainable if[29]

$$\gamma \leq \min \left\{ \gamma_1 = \frac{9w_{A1} - 3\sqrt{w_{A1}\,(8w_1 + 5w_{A1})}}{4}, w_{A1} - 2w_1 \right\}.$$

[29] Note that $w_1 < w_A$ implies $\gamma_1 > 0$, and thus the existence of a non-empty admissible range for γ.

4 Ban of Loss Leading: Welfare Analysis

The previous analysis shows that the large retailer can exploit extra rents from the more efficient rival by using loss leading strategy, and in this way makes even higher profit than the monopolistic level. This begs the question–can social welfare be increased when loss leading is prohibited? In this section, we give the answer unambiguously.

Suppose that the large retailer is not allowed to charge prices below cost, it would then optimally charge $r_1 = 0$ for product B, which yields a profit $r_{A1}G(v_{A1})$. In equilibrium, the large retailer instead earns the monopolistic profit Π_1^m by charging $r_A = r_{A1}^m$, while the small retailer maximizes its profit by charging $r_2 = h(\tau)$, where $\tau = \gamma - (r_2 - r_1) = \gamma - h(\tau)$, this leads to the equilibrium threshold of shopping cost below which consumers would prefer multi-shopping:[30]

$$\tau = \tau^b \equiv l^{-1}(\gamma).$$

Since $l^{-1}(\gamma) > j^{-1}(\gamma)$, it follows that $\tau^b > \tau^*$, that is, the small retailer now faces higher demand from cherry-pickers and thus makes more profit: $h(\tau^b)G(\tau^b) > h(\tau^*)G\tau^*)$. While one-stop shoppers face the same monopolistic price as before and thus their welfare v_{A1} is not affected, cherry-pickers actually benefit from a ban of below-cost pricing as

$$v_{A2}^b \equiv v_{A1}^m + \tau^b > v_{A1}^m + \tau^* = v_{A2}^*.$$

It follows that banning loss-leading could increase total consumer surplus (since it increases the option value for cherry-pickers, without affecting the value of one-stop shopping).

More precisely, we can write social welfare as a function of τ:

$$\begin{aligned} W(\tau) &= \int_{\tau}^{v_{A1}} (w_{A1} - t)dG(t) + \int_{0}^{\tau} (w_{A2} - 2t)dG(t) \\ &= \int_{0}^{v_{A1}} (w_{A1} - t)dG(t) + \int_{0}^{\tau} (\gamma - t)dG(t), \end{aligned}$$

where, in the first line, the first term represents the total welfare from one-stop shopping while the second term is the social welfare from multi-shopping, and the second line is obtained by using the fact that $w_{A2} = w_{A1} + \gamma$. Notice that the surplus of one-stop shoppers are not affected (so the first term remains unchanged), it follows that social welfare is increasing in τ, since both τ^* and τ^b are less than γ. Therefore $W(\tau^b) > W(\tau^*)$ implies that banning loss-leading increases social welfare. In particular, this tends to reduce the inefficiency in distribution as noted in the

[30] We employ the superscript b to refer to the case when below-cost pricing is banned.

previous section: while consumers whose shopping cost lies between τ^b and γ still buy product B inefficiently from the large retailer, the small retailer now serves more efficiently the consumers whose shopping cost lies between τ^* and τ^b.

When below-cost pricing is prohibited, the large retailer can still make a profit equal to the monopolistic level in equilibrium, it therefore has no incentives to exclude the rival. The equilibrium is still sustainable when $\gamma \leq \gamma_1$ as shown in Appendix C, and is unique as before since, by the same logic, regime D cannot arise in equilibrium when $\gamma \leq w_{A1} - 2w_1$. These findings are summarized in the following proposition:

Proposition 2 *Assume $\gamma \leq \{\gamma_1, w_{A1} - 2w_1\}$ and below-cost pricing is banned. There exists a unique Nash equilibrium, in which the large retailer sells the competitive good at cost and makes the monopolistic profit for the bundle of both products; consequently, the small retailer's profit, consumer surplus and social welfare are higher than in the case when below-cost pricing is not prohibited.*

Proof. See Appendix C. ■

While most countries have laws equipped to deal with predatory pricing by a multiproduct retailer, competition authorities are ill equipped to evaluate loss leading as in most cases it is implausible to establish recoupment and the feasibility of predation for loss leading pricing. For instance, the Office and Fair Trading (1997) in the UK argues that in an analysis of an allegation of predation for retailing cases, a price-cost comparison will be of little use, since pricing below cost on individual items may be profitable without being predatory due to possible loss leading effect. The same dilemma faces the UK Competition Commission (2000, 2008), which argues that the necessary conditions for an alleged predation are unlikely to be met in loss leading cases.

Our analysis shows that loss leading can be used as an exploitative practice by a dominant retailer, which aims to exploit rents from a smaller but more efficient rival, rather than as an exclusive or predatory device to foreclose the rival, moreover banning of loss leading could increase consumer surplus and social welfare unambiguously. These findings thus provide a theoretical ground for the evaluation of the anticompetitive effect in loss leading cases and the intervention of loss leading pricing in practice.

5 Extensions: Heterogeneous Preferences

5.1 Heterogeneous Consumer Preferences for Good B

The assumption that consumers have homogeneous valuations on good A and B allows us to disentangle the effect that loss leading pricing may arise as an optimal pricing strategy for multiproduct with different demand elasticities. In the environment where consumers have heterogeneous valuations on good B, however, one may expect that the large retailer can attract more consumers to buy product B and thus product A by cutting the price p_1, and even make more profit by charging $p_1 < c_1$. However, we show that loss leading cannot arise as an optimal pricing strategy for a multi-product firm when the large retailer is the monopolist in both market, whereas loss leading pricing prevails as a facilitation of rent extraction when the large retailer competes with the small retailer in product B.

To fix ideas, we assume that consumer shopping cost is uniformly distributed with $G(x) = x$, while consumer preferences on good B are also uniformly distributed between $[0, 1]$, independently from the distribution of shopping cost, and moreover both products are independent so $u_{AB} = u_A + u_B$. Without loss of generality, we assume $c_2 = 0$ and $0 < c_1 < 1$. Notice that the thresholds τ and v_A that determine consumer's choices between one-stop shopping and two–stop shopping are not affected by the valuation u_B, so the classification and characterization of regimes S and D are exactly the same as before.

Consider regime S where the large retailer offers higher value than its rival for one-stop shoppers, that is, $v_{A1} \geq v_2$, or $v_A \geq \tau$. One-stop shoppers visit the large retailer when $t \leq v_{A1}$; they buy both products in the large retailer if $u_B \geq p_1$ and $t > \tau$. Consumers with valuation $p_2 < u_B < p_1$ will instead visit both stores if $t \leq v_2 = u_B - p_2$ ($t \leq \tau < v_A$). Finally, consumers with valuation $u_B \leq p_2$ never buy product B, and they will buy product A only if $t \leq v_A$. The characterization of consumer choices is illustrated in Figure 1, where in region $A1$ consumers buy the bundle of products A and B from retailer 1, in region $A2$ consumers purchase product A from retailer 1 and product B from retailer 2, and in region A consumers buy product A only.

In regime S, the large retailer faces a demand for the bundle from one-stop shoppers

$$\int_{p_1}^{1} \int_{\tau}^{v_{A1}} du_B dt = (1 - p_1)(v_A - \tau) + \frac{(1 - p_1)^2}{2},$$

and an additional demand for product A from cherry-pickers as well as from those consumers preferring product A only, which equals to $\tau(1 - p_1) + v_A p_1$; the large retailer's profit can be

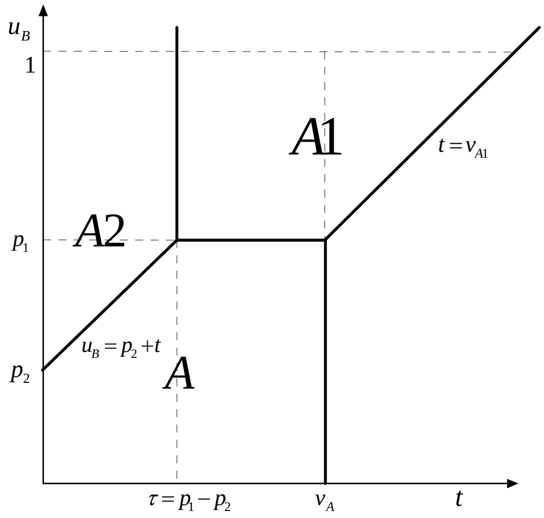

Figure 1:

written as

$$\begin{aligned}\Pi_1 &= r_{A1}(1-p_1)\left(v_A + \frac{(1-p_1)}{2} - \tau\right) + r_A(\tau(1-p_1) + v_A p_1) \\ &= r_{A1}(1-p_1)\left(v_A + \frac{(1-p_1)}{2}\right) + r_A v_A p_1 - r_1\tau(1-p_1).\end{aligned}$$

Meanwhile the small retailer faces a demand from cherry-pickers with $t \leq \tau$ and $u_B - p_2 \geq t$, which is equal to

$$\int_0^\tau \int_{p_2+t}^1 du_B dt = \tau(1-p_2) - \frac{\tau^2}{2} = \tau(1-r_2) - \frac{\tau^2}{2},$$

where the last equality comes from the fact that $c_2 = 0$ by assumption; the small retailer then makes a profit

$$\Pi_2 = r_2\left(\tau(1-r_2) - \frac{\tau^2}{2}\right).$$

Reducing the price p_1 increases the shopping traffic and thus attract more consumers to buy product A, however, it is never optimal for the large retailer to charge the price below cost and thus incur a loss in market B in the absence of the rival, as shown in Appendix D. When facing competition in market B, pricing p_1 below cost exerts a competitive pressure on the small retailer and in this way lowers the retail margin of the small retailer, and the large retailer could then extract some efficient rents from the small retailer by increasing the price for product A and thus exploiting the cherry-pickers who benefit from the reduction of price p_2. While raising the price of product A will reduce the demand from consumers who has lower valuation of product B and thus only buy product A only from the large retailer, reducing the price p_1 below cost would offset this effect by attracting more consumers to buy both products in the large retailer. Therefore the logic of rent-extraction through loss-leading still prevails when consumers have heterogeneous preferences over product B, and consequently loss leading arises in equilibrium.

When price-below-cost is not allowed, the large retailer cannot exploit from the more efficient rival by employing loss leading pricing, and social welfare increases as a result. These main results are summarized in the following proposition, while detailed analyses are demonstrated in the Supplementary Appendix:

Proposition 3 *Suppose consumers' preferences over product B and shopping costs are independently and uniformly distributed. Loss leading cannot arise as the optimal pricing strategy in the monopoly case, whereas it does arise in equilibrium as an exploitative device when the large retailer competing with smaller but more efficient rival; moreover social welfare increases when loss leading is banned.*

5.2 Heterogeneous Consumer Preferences for Product A

We now consider the case where consumers have heterogeneous preferences for product A, which are uniformly distributed between 0 and 1, and independent with the uniform distribution of consumer shopping cost. Assume consumers have homogeneous preferences over product B; it is then optimal to charge a price p_1 or p_2 lower than u_B.

It appears that below-cost pricing for product B is never optimal in the monopoly case, as shown in the supplementary appendix. However, whenever retailer 1 faces competition in product B from retailer 2, loss leading arises in equilibrium.

To see this, recall that one-stop shoppers will buy both products from retailer 1 if $t \leq v_{A1}$ and $v_{A1} \geq v_2$, or

$$u_A - p_A + v_1 \geq t \text{ and } u_A \geq p_A + \tau;$$

while consumers prefer to one-stop shopping rather than two-stop shopping if $t \geq \tau$. Therefore the large retailer faces a demand of both products equals to

$$\int_{p_A+\tau}^{1} \int_{\tau}^{v_{A1}} du_A dt = (1 - p_A - \tau)\, v_1 + \frac{(1 - p_A - \tau)^2}{2},$$

which is illustrated by region $A1$ in Figure 2. In addition, the large retailer also faces a demand of product A from cherry-pickers with $t \leq \tau$ and $u_A - p_A \geq t$, which is equal to

$$\int_{0}^{\tau} \int_{p_A+t}^{1} du_A dt = (1 - p_A)\, \tau - \frac{\tau^2}{2},$$

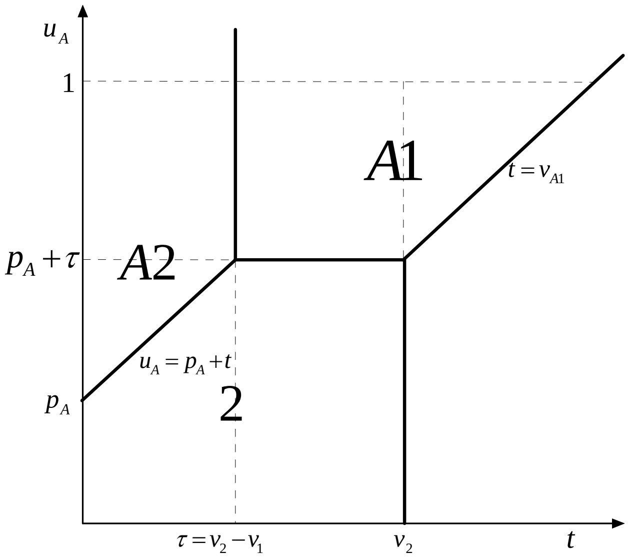

Figure 2:

as depicted by region $A2$ in Figure 2. The large retailer thus earns a profit

$$
\begin{aligned}
\Pi_1 &= r_{A1}\left((1-p_A-\tau)\,v_1 + \frac{(1-p_A-\tau)^2}{2}\right) + r_A\left(\frac{\tau^2}{2} + (1-p_A-\tau)\,\tau\right) \\
&= r_{A1}\left((1-p_A-\tau)\,v_1 + \frac{(1-p_A)^2}{2}\right) - r_1\left(\frac{\tau^2}{2} + (1-p_A-\tau)\,\tau\right).
\end{aligned}
$$

On the other hand, the small retailer faces a demand from consumers who have lower valuation for product A satisfies $v_{A1} < v_2$ (and also $t \leq v_2$), that is

$$u_A < p_A + \tau \text{ and } t \leq v_2,$$

and who have higher valuation for product A and lower shopping cost such that $u_A \geq p_A + \tau$ and $t \leq \tau$, which, as illustrated in region 2 and $A2$ in Figure 2, is equal to

$$\tau + v_1(p_A + \tau),$$

therefore the small retailer makes a profit

$$\Pi_2 = r_2\left(\tau + v_1(p_A + \tau)\right).$$

(Insert Figure 2 here.)

Applying the same logic as before, we obtain the following result:

Proposition 4 *Suppose consumers' preferences over product A are uniformly distributed and independent with the uniform distribution of shopping cost, then loss leading cannot arise in equilibrium as the optimal pricing strategy in the monopoly case, however it can be adopted by the large retailer to exploit from the smaller but more efficient rival in equilibrium.*

Proof. See Supplementary Appendix. ∎

6 Conclusions

Loss leading pricing strategy is commonly adopted by multi-product retailers. It is often referred to as an advertising strategy which allows retailers to attract consumers by subsidizing some products and make profits from other items; in this way, below-cost pricing may improve consumer welfare by compensating consumers for their lack of information. This paper shows that large retailers can instead use loss leading as an exploitative device at the detriment of smaller retailers, without any efficiency justification in terms of distribution cost or advertising. We show further that banning below-cost pricing can unambiguously increase consumer surplus and social welfare as well as smaller retailers' profit.

However, we appeal for a cautious antitrust intervention against loss leading, as it's harmful impact on competition depends on the concrete economic environment. In particular, the large retailer can use loss leading to exploit the more efficient but smaller rival only when it owns monopoly power in some product lines, by which it can extend the monopoly power to the competitive products through loss leading pricing. Whether in other economic environments the dominant retailer can use loss leading to exploit or exclude its rival remains an open question and deserves for further studies.

Appendices

Appendix A: Quasi-concavity of Profit Functions

We check the quasi-concavity of profit functions. In the monopolistic case, the large retailer makes a profit

$$\Pi = r_{A1} G(w_{A1} - r_{A1});$$

differentiating with respect to r_{A1}, we obtain

$$\frac{\partial \Pi_1}{\partial r_{A1}} = g(w_{A1} - r_{A1}) \left(h(w_{A1} - r_{A1}) - r_{A1} \right),$$

and the first-order condition yields $h(w_{A1} - r^m_{A1}) = r^m_{A1}$, which is a local maximum since

$$\frac{\partial^2 \Pi_1}{\partial r^2_{A1}}|_{r^m_{A1}} = -g(w_{A1} - r_{A1})\left(h'(w_{A1} - r_{A1}) + 1\right) < 0.$$

Moreover, since $h(\cdot)$ is strictly increasing by assumption, the function $h(w_{A1} - r_{A1}) - r_{A1}$ is strictly decreasing in r_{A1}, it follows that the local optimum $r^m_{A1} = h(w_{A1} - r^m_{A1})$ is a unique and thus a global maximum.

We can write the profit function of the large retailer and the small retailer in regime S as

$$\Pi_1 = r_{A1}G(w_{A1} - r_{A1}) - r_1 G(\gamma + r_1 - r_2).$$

Notice that Π_1 is separable in variables r_{A1} and r_1, where $r_{A1}G(w_{A1} - r_{A1})$ is strictly quasi-concave in r_{A1} and $-r_1 G(\gamma + r_1 - r_2)$ is strictly quasi-concave in $-r_1$ by the same logic, it follows that the local optimum given by $r^*_{A1} = h(w_{A1} - r^*_{A1})$ and $r^*_1 = -h(\gamma + r^*_1 - r_2)$ is also the global maximum and therefore the interior solution is unique.

By analogy, the optimal retail margin of the small retailer $r^*_2 = h(\gamma + r_1 - r_2)$, which maximizes $\Pi_2 = r_2 G(\gamma + r_1 - r_2)$ is a unique and thus a global maximum.

Appendix B: Proof of Proposition 1

The large retailer must ensure that $v_{A1} \geq v_2$ in any candidate equilibrium of regime S in order to attract one-stop shoppers, that is, the retail margins must satisfy

$$r^*_2 \geq r^*_{A1} - \Delta. \quad (S1)$$

Moreover, the following constraints must be satisfied for the equilibrium:

- The large retailer has no incentives to deviate to regime D, by which it can make a monopolistic profit for product A: $\Pi^{mA}_1 = G(v^m_A)h(v^m_A)$. This condition always hold as $\Pi^{mA}_1 < \Pi^m_1 < \Pi^*_1$.

- The small retailer cannot benefit from undercutting and deviating to regime D, by which it can earn a profit

  $$\widehat{\Pi}_2 = r_2 G(w_1 + \gamma - r_2),$$

  subject to the constraint $r_2 \leq r^*_{A1} - \Delta$. This condition can be satisfied when the optimal profit under deviation $\widehat{\Pi}^d_2$ does not exceed the optimal profit under regime S, i.e.,

  $$\widehat{\Pi}^d_2 \leq \Pi^*_2. \quad (S2)$$

To seek for the small retailer's optimal profit from deviation, notice that the optimal retail margin in regime D solves the following first-order condition

$$r_2^D = h(w_1 + \gamma - r_2^d).$$

Recall that $r_1 < w_1$ and $h(\cdot)$ is increasing, it follows that $r_2^D > r_2^*$, that is, the the optimal retail margin under regime D exceeds that under regime S. It appears that the maximum in regime D cannot be reached by deviating from regime S which requires to undercut r_2 from r_2^* and thus departs further from r_2^D. Consequently the optimal deviation must be achieved at the boundary of two regimes, which satisfies $r_2 = r_{A1}^* - \Delta$.

Substituting the optimal profit under deviation into condition ($S2$), and by rearranging we obtain the no-deviation condition for the small retailer

$$r_2^* = h(\tau^*) \geq (r_{A1}^* - \Delta)\,\frac{G(v_{A1}^*)}{G(\tau^*)}. \quad (S3)$$

Notice that $v_{A1}^* > \tau^*$, so the right-hand-side of condition ($S3$) exceeds $(r_{A1}^* - \Delta)$. It follows that $r_2^* > r_{A1}^* - \Delta$, therefore condition ($S1$) is implied by condition ($S3$) and is not relevant.

Rearranging condition ($S3$), we get

$$\Psi(\gamma) \equiv \gamma - \frac{h(\tau^*)G(\tau^*)}{G(v_{A1}^*)} \leq w_{A1} - w_1 - h(v_{A1}^*).$$

Differentiating $\Psi(\gamma)$ with respect to γ and using the relation

$$\frac{d\tau^*}{d\gamma} = \frac{1}{1 + 2h'(\tau^*)},$$

we obtain

$$\Psi'(\gamma) = 1 - \frac{G(\tau^*)\,(1 + h'(\tau^*))}{G(v_{A1}^*)\,(1 + 2h'(\tau^*))} > 0.$$

Therefore $\Psi(\cdot)$ is strictly increasing and the equilibrium condition ($S3$) can be further written as

$$\gamma \leq \gamma_1 \equiv \Psi^{-1}(w_{A1} - w_1 - h(v_{A1}^*)),$$

where Ψ^{-1} is the inverse function of Ψ.

Appendix C: Proof of Proposition 2

By the same logic, when below-cost pricing is banned, the equilibrium can be sustained if

$$\gamma \leq \gamma_1^b = \Psi_b^{-1}(w_{A1} - w_1 - h(v_{A1}^*)),$$

where

$$\Psi_b(\gamma) \equiv \gamma - \frac{h(\tau^b)G(\tau^b)}{G(v_{A1}^*)},$$

with $\tau^b = l^{-1}(\gamma) > \tau^*$.

Notice that γ_1 is the fixed point of the equation

$$\gamma = \Gamma(\gamma) \equiv \frac{h(\tau^*)G(\tau^*)}{G(v_{A1}^*)} + w_{A1} - w_1 - h(v_{A1}^*),$$

while γ_1^b solves the equation

$$\gamma = \Gamma^b(\gamma) \equiv \frac{h(\tau^b)G(\tau^b)}{G(v_{A1}^*)} + w_{A1} - w_1 - h(v_{A1}^*);$$

it follows that $\gamma_1^b > \gamma_1$ since $\Gamma^b(\gamma) > \Gamma(\gamma)$. Therefore the equilibrium is still sustainable when $\gamma \leq \gamma_1^b$.

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