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"Private Label Positioning and Product Line"

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Abstract

This article examines (i) how retailers position private label products, (ii) why private labels are sold in some product categories but not in others, and why some national brand products may have difficulty in accessing retailers' shelves, (iii) why some private label products are positioned as "premium" brands, and (iv) how consumers' surplus and total welfare are affected by private labels. We find that private label positioning leads to less differentiation in product category, which structurally changes a retailer's product line in return. Consumer welfare and total welfare are lower.

JEL Classification: L13, L81.
Keywords: Private Label, National Brand, Product Line.

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1 Introduction

Private Labels (PLs), also known as store brands, are typically goods sold under a retailer's brand which can be the retailer's own name or a name created exclusively by that retailer. Private-label goods are available in a wide range of industries from food to cosmetics. According to a report by Nielsen (2014), private label products account for 18 percent of the U.S. and Canada retailing markets in value (2013 data) and more than twice this figure in some European countries (Switzerland at 45%, United Kingdom at 41%, Spain at 41%, 2013 data), and are now well developed in most countries throughout the world. In India, PLs constitute 5% of sales (2014 data; Nielsen report, 2014), and "they grew 27% between 2012 and September 2014".

However, PL market shares and their positioning with respect to National Brand (NB) products exhibit widespread diversity across product categories. For example, for 38 countries the PLs aggregated value shares were, on average, 32 percent in refrigerated food, five percent in personal care products and two percent in baby food (ACNielsen, 2005). In addition, while PL products were priced, on average, 31 percent lower than their manufacturer counterparts, the average price differentials on a category basis ranged from 46 percent in personal care products to just 16% for refrigerated food. Interestingly, there was no direct correlation between the lower price and the largest market share: while the value shares of PLs were 32 percent in refrigerated food and two percent in baby food, refrigerated food and baby food were priced 16 percent lower and 24 percent lower respectively, than their manufacturer counterparts. Moreover, at the individual country/category level, "there were a number of examples where PL products had an average price that was actually higher than the manufacturer brands" (ACNielsen, 2005). One reason for this, is that while PL products can be positioned as lower-cost alternatives to NB products, some retailers have also positioned their PL brands as "premium" brands. Retailers such as Tesco in the U.K. and Loblaws in Canada, for example, have now both added these PL offerings to their product assortments.[1] With growing market shares of PL products and/or the premium brand

[1] Alongside the Tesco Value brand (usually depicted by blue and white stripes), Tesco has a premium quality brand, Tesco Finest, which also spans most product areas in the store (ACNielsen, 2005). Overall, Tesco has also developed Tesco Organics with a variety of organic foods from cookies to sausages, and Tesco Free, including over 150 products which are gluten, wheat or milk free.

Since President's Choice (PC) products were launched in 1984, Loblaws has expanded the brand beyond a price-point focus in order to offer quality, health-focused alternatives to consumers in Canada, positioning of some PL brands, some categories exhibit a level of tension between NB producers and retailers, and NB suppliers may face problems in accessing the shelves of retailers.

To date, the literature on this subject has studied a number of reasons for a retailer to launch PL products with two main motivations suggested: first, segmenting the market, and second, strengthening the bargaining power of a retailer.[2] In respect to market segmentation, by differentiating the products in one product line with several brands, firms are able to weaken the competition with their rivals, which improves their market power (see Shaked and Sutton, 1982, for example; see also Brander and Eaton, 1984, Champsaur and Rochet, 1989 and Gilbert and Matutes, 1993 in which firms choose their product lines[3]). Launching a PL is also considered as an instrument to strengthen the retailer's bargaining power against NB suppliers. Earlier studies include Mills (1995), Bontems et al., (1999) and Mills (1999).[4] For example, Mills (1995) shows that PL products are introduced because they induce a price concession of NB producers and, hence, limit the market power of NB producers. In other words, when a new substitute is supplied by the retailer and competes with the existing good, the problem of double marginalization is reduced. When PL products are introduced (or because of the threat of supplying PLs), industry surplus and consumer surplus are higher, which results in

as well as the United States, the Caribbean, Hong Kong and Israel (for example PC Blue Menu, PC Organics, PC Mini Chefs; ACNielsen, 2005).

See also Caprice (2000), for examples in France (Carrefour with "Filière Qualité", "Escapades Gourmandes").

[2] Other reasons have been used to justify the production of PL products. For example, Bergès and Bouamra-Mechemache (2012) shows that NB manufacturers may use their excess production capacities to produce PL products. They study the retailer's and NB manufacturer's PL strategy for production in a setting featuring endogenous store brand quality, bargaining power, possible differences in production technology and potential capacity constraints for the NB manufacturer. Depending on the structure of capacity constraint (applying to both products or to PL only), they find that the retailer may prefer to choose an independent firm for the production of PL product whereas the NB manufacturer is chosen in the case of excess capacity.

In an environment of imperfect information where consumers do not know the quality of the PL product before purchase, Bergès-Sennou and Waterson (2005) and Chen and Xu (2015) also examine what determines the presence or absence of private labels (as experience goods) in groceries.

[3] These latter papers define multi-stage games in which firms first choose their product lines and then compete on the market.

[4] More recently, see also Gabrielsen and Sorgard (2007) with brand loyalty consumers. Other studies such as Narasimhan and Wilcox (1998) have also considered brand loyalty consumers. By contrast, Bergès-Sennou (2006) has considered store loyalty consumers. In any case, consumers' loyalty affects the retailer's bargaining position, but also the retailer's assortment, of available products.

See also Bergès et al., (2004) for a survey.

higher social welfare (as long as fixed costs are low).

Results from empirical studies are more ambiguous on this issue. Some studies find that the price of NB products decreases when PL products are introduced (or when the market share of PLs is larger), while others find the opposite.[5] For example, Ward et al., (2002) show that an increase in the PL market share is consistent with an increase (or no change) in the price of national brands. While theoretical studies suggest that the impact of PLs on the retail prices of NB products is negative, results from empirical studies are far from clear. Moreover, while previous theoretical papers assume that NB suppliers use linear pricing, recent empirical analysis shows that non-linear pricing is prevalent, especially when suppliers contract large retailers.[6]

In this paper, we consider a simple setup where the producer of a NB sells its brand through a single retailer and the retailer considers the choice of the characteristics of its PL product. As it is common to argue that there are quality differences between NB and PL, we assume that both products are vertically differentiated. The marginal cost of the PL product is increasing and convex in the quality (objective quality). Initially, we consider the industry outcome when the quality of PL product is chosen in order to maximize industry surplus. Then, we restrict attention to the case where the quality of the PL product is lower than the quality of the NB product and study the following three stage game where first, the retailer chooses the quality of the PL product, second, the NB producer offers a non-linear tariff, and finally, the retailer sets retail prices. The timing of the game is familiar as contracting decisions present a lower degree of irreversibility than quality choices. As the retailer owns and controls the brand, the choice in regard to quality is made by the retailer. This timing underlines an essential feature of PL products: the characteristics of PL products are fixed by retailers and not by manufacturers. Moreover, these decisions are strategically taken in order to enable retailers to increase their profits. As expected, because the retailer chooses the quality of the PL product so as to maximize its disagreement payoffs, the quality is higher than the quality which maximizes industry profits. This result highlights one major difference when we compare the quality choice of a NB producer and the quality choice of a retailer

[5] We can cite, for example, Putsis (1997), Cotterill et al., (2000), Chintagunta et al., (2002) and Ward et al., (2002); more recently, see also Bontemps et al., (2008).

[6] See Villas-Boas (2007) and Bonnet and Dubois (2010) for seminal papers, showing evidence of such contracts in vertical contracting.

on PL. While the former considers the incremental contribution of its good to the surplus of the product category, which leads to industry surplus maximization, the latter takes into account its disagreement payoff. As the quality chosen by the retailer for the PL product is higher, the total demand which is supplied in the product category is smaller. Moreover, the retail price of the NB product is unchanged in this setting. We then show that consumer surplus and total welfare are lower when the retailer chooses the quality of its PL product in comparison with the situation in which the quality would be chosen optimally. This is because total demand is lower in the former case.

Thus, we characterize in detail the retailer's product line when the retailer positions its PL product. In particular, we show that the demand for the NB product may be zero in some cases at equilibrium, which raises the issue of access to shelves for the NB producers.[7] By contrast, the PL product is not sold in some cases at equilibrium. Another situation can arise, in which the retailer may choose the quality of the PL product which is higher than the quality of the NB product, which may explain premium PL products in some product categories. We then discuss our results with respect to different scenarios: first, we consider an alternative game in which the NB manufacturer can ex-ante commit to contract terms (before PL positioning), and second, we allow for competition between NB producers. In the former scenario, the retailer – not unsurprisingly – chooses PL quality which maximizes industry surplus. In the latter scenario, similar insights arise when the competition between NB manufacturers is fierce. In both cases, PL positioning now allows the retailer to price discriminate between consumers.

Our results are in line with the findings of Scott-Morton and Zettelmeyer (2004).[8] Using a bargaining framework, they study a retailer's decision whether to carry an additional NB or a PL and, if the retailer chooses to introduce the latter, where in product space to locate the PL product. They show that the strategic positioning of a PL product in a category changes the bargaining over supply terms between a retailer and a NB manufacturer in that category, and clearly differs from the strategic positioning of another NB manufacturer. PL positioning causes a reduction of differentiation in product category. However, in their analysis, PL and NB products are always supplied

[7] The result is due to the finiteness property (Gabszewicz and Thisse, 1979; Shaked and Sutton, 1983) in vertically differentiated markets. In such an analysis, the number of products with a positive market share depends on the degree of consumer heterogeneity.

[8] See also, Choi and Coughlan (2006) for similar insights.

at equilibrium (or another NB product and the original NB). They assume constant marginal cost of production for both PL and NB products. By contrast, we assume increasing marginal cost in quality for the PL product. We can thus study in detail the equilibrium product line of the retailer with respect to the positioning of the PL product. We find that the PL product or the NB product are not sold in some cases. Moreover, while their model is not designed to study premium PL products such as President's Choice for Loblaws in Canada, our model allows us to consider this PL positioning.

There is now a literature which investigates the role of PLs in oligopolistic downstream markets (Avenel and Caprice, 2006; Colangelo, 2008 and more recently Bonroy and Lemarié, 2012). For example, Avenel and Caprice (2006) consider two competing retailers; they study a vertical differentiation model where a high quality item (i.e., a NB) is offered by a monopolist, while low quality items (i.e., PL products) are offered by a competitive fringe. They show that the equilibrium product line depends on the positioning of PL products. When PL and NB products are close substitutes, the NB manufacturer prefers to deal with both retailers in order to affect retailers' outside options, that is, the profits that retailers obtain with their PL products. By contrast, in this paper, we assume a monopoly retailer, leaving aside the issue of how PL products interact with retailer competition. In doing so, we focus on interbrand competition (i.e., competition between products at one retailer), when the retailer is a monopoly.

The rest of the paper is organized as follows. Section 2 introduces the model. We analyze PL positioning when the industry is fully vertically integrated in Section 3 (this case will be used as a benchmark case). Section 4 solves the model and presents results. Consumer surplus and total welfare are also studied. We discuss results in Section 5 and Section 6 concludes.

2 The model

The industry consists of an upstream market and a downstream market. In the upstream market, a manufacturer produces a national brand (NB) product with quality s_{NB} at a constant marginal cost c_{NB}. In the downstream market, a monopolistic retailer buys and resells the NB product. The retailer, meanwhile, has the option of producing and selling a private label (PL hereafter) product with quality s_{PL}. The retailer chooses the quality of the PL product. The marginal cost of producing a PL does not depend on the quantity, but is increasing and convex in the quality level. We assume that the marginal cost of producing s_{PL} is given by $C_{PL}(s_{PL}) = \frac{s_L^2}{2}$. We do not restrict the analysis by having more assumptions on costs. In particular, we will say that the retailer benefits from a competitive advantage when for identical levels of quality the marginal cost of producing a PL is smaller than the marginal cost of producing the NB product: $C_{PL}(s_{NB}) < c_{NB}$ ($\Leftrightarrow \frac{c_{NB}}{s_{NB}} < \frac{s_{NB}}{2}$). On the contrary, the retailer faces a competitive disadvantage when $C_{PL}(s_{NB}) > c_P$ ($\Leftrightarrow \frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$). We suppose that there are no barriers to entry to the production and sales for the PL product. Accordingly, there are a large number of upstream firms that can produce the PL product and the retailer purchases the PL product at marginal cost $C_{PL}(s_{PL})$.[9] Consumers have perfect information about the quality of products.

We suppose that the contract between the NB manufacturer and the retailer takes the form of a two-part tariff $T = (w, F)$, which is proposed by the manufacturer, where w and F denote the wholesale price and the fixed fee charged to the retailer, respectively. The retailer sells the NB product and the PL product at p_{NB} and p_{PL} (in the event where the retailer accepts the contract proposed by the manufacturer).

Following the quality-choice model of Mussa and Rosen (1978), we assume that consumers are indexed by their preferences θ, with θ uniformly distributed on an interval $[0, a]$ (density, $\frac{1}{a}$). There is a unit mass of consumers. Consumers at different locations on the interval $[0, a]$ have different tastes for quality. Specifically, the net surplus of a consumer θ is given by $U(\theta, p_k, s_k) = \theta s_k - p_k$ ($k = NB, PL$) if he purchases a product k of quality s_k and zero otherwise. By denoting i the good with higher quality and j the other product, the marginal consumer who is indifferent about buying the good i and the good j is given by $\theta_{ij} = \frac{p_i - p_j}{s_i - s_j}$, while the marginal consumer who is indifferent about buying the low quality good and not buying at all is determined by $\theta_{j\oslash} = \frac{p_j}{s_j}$. We

[9] An alternative interpretation would be to consider that the retailer is vertically integrated and produces PL product at $C_{PL}(s_{PL})$.

can write the demands as follows:

$$D_i(p_i, p_j) = \begin{cases} 0 & \text{if } p_i \geq \widehat{p}_i(p_j) \text{ or if } p_i \geq as_i \\ a - \frac{p_i - p_j}{s_i - s_j} & \text{if } \widetilde{p}_i(p_j) \leq p_i < \widehat{p}_i(p_j) \\ a - \frac{p_i}{s_i} & \text{if } p_i < \widetilde{p}_i(p_j) \end{cases}$$

$$D_j(p_i, p_j) = \begin{cases} 0 & \text{if } p_j \geq \widetilde{p}_j(p_i) \text{ or if } p_j \geq as_j \\ \frac{p_i - p_j}{s_i - s_j} - \frac{p_j}{s_j} & \text{if } \widehat{p}_j(p_i) \leq p_j < \widetilde{p}_j(p_i) \\ a - \frac{p_j}{s_j} & \text{if } p_j < \widehat{p}_j(p_i) \end{cases}$$

with $\widehat{p}_i(p_j) = a(s_i - s_j) + p_j$ and $\widetilde{p}_i(p_j) = p_j \frac{s_i}{s_j}$ $(i, j = NB, PL)$.

In the case where the retailer does not accept the offer of the NB manufacturer, we denote $p_{NB} = +\infty$ the retail price of the NB product. It can also be optimal for the retailer to not sell the PL product in case PL and NB products are close substitutes, and we denote $p_{PL} = +\infty$ the retail price of PL product in this case.

We study the following game:

- at stage one, the retailer chooses the quality s_{PL} of its PL product;

- at stage two, offers (w, F) are made by the NB manufacturer to the retailer, which the retailer either accepts or rejects; and

- then, at stage three, the retailer sets retail prices p_{PL} and p_{NB}.

The timing of the game is not surprising as contracting decisions present a lower degree of irreversibility than the choice of quality. In particular, the development of PL products is subject to various stages, such as the definition of specifications, a call for tenders to the production sector, manufacturing by the chosen supplier, and quality control on the production site, which suggests a long process and thus constitutes an irreversible choice. By contrast, the terms of a contract can be modified more easily and therefore have a lower degree of irreversibility.[10] The retailer owns and controls the PL brand which results in a quality choice of PL product s_{PL} made by the retailer.

In the next section, we consider the situation where the industry is fully vertically integrated and PL positioning maximizes industry surplus. We will use this as a benchmark case.

[10] Other demand side factors may also explain a relative rigidity in product quality. Consumer quality assessment may involve a certain degree of subjectivity, thus making the product quality change process relatively long, in comparison with contract designing.

3 PL positioning in a fully vertically integrated industry

Industry surplus involves sales from PL and NB products, that is, the maximization problem is given by:

$$\begin{aligned} Max\ \Pi_I\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right) &= \left(p_{PL} - C_{PL}\left(s_{PL}\right)\right) D_{PL}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right) \\ &\quad + \left(p_{NB} - c_{NB}\right) D_{NB}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right), \end{aligned}$$

which results in the following first-order conditions in retail prices:

$$\begin{aligned} &\left(p_{PL} - C_{PL}\left(s_{PL}\right)\right) \frac{\partial D_{PL}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right)}{\partial p_{PL}} + D_{PL}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right) \\ &\qquad + \left(p_{NB} - c_{NB}\right) \frac{\partial D_{NB}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right)}{\partial p_{PL}} = 0, \end{aligned}$$

$$\begin{aligned} &\left(p_{PL} - C_{PL}\left(s_{PL}\right)\right) \frac{\partial D_{PL}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right)}{\partial p_{NB}} + \left(p_{NB} - c_{NB}\right) \frac{\partial D_{NB}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right)}{\partial p_{NB}} \\ &\qquad + D_{NB}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right) = 0. \end{aligned}$$

We obtain $p_{PL}^{e}\left(s_{PL}, s_{NB}\right)$ and $p_{NB}^{e}\left(s_{PL}, s_{NB}\right)$.[11]

First-order condition in the quality of the PL product results in:

$$\begin{aligned} &\left(p_{PL} - C_{PL}\left(s_{PL}\right)\right) \frac{\partial D_{PL}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right)}{\partial s_{PL}} + \left(p_{NB} - c_{NB}\right) \frac{\partial D_{NB}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right)}{\partial s_{PL}} \\ &\qquad - C'_{PL}\left(s_{PL}\right) D_{PL}\left(p_{PL}, p_{NB}, s_{PL}, s_{NB}\right) = 0. \end{aligned}$$

Substituting p_{NB} and p_{PL} by, $p_{PL}^{e}\left(s_{PL}, s_{NB}\right)$ and $p_{NB}^{e}\left(s_{PL}, s_{NB}\right)$, and solving for s_{PL}, we obtain the quality of the PL product which is optimal from the point of view of

[11] Simple calculations lead to

$$p_{PL}^{e}\left(s_{PL}\right) = \frac{1}{2}\left(C_{PL}\left(s_{PL}\right) + a s_{PL}\right) \text{ and } p_{NB}^{e}\left(s_{PL}\right) = \frac{1}{2}\left(c_{NB} + a s_{NB}\right)$$

for $D_{PL}\left(.\right) > 0$ and $D_{NB}\left(.\right) > 0$.

industry surplus. Let s^*_{PL} denote this optimal quality. s^*_{PL} depends crucially on the size of the market a and the relative production cost of the NB product $\frac{c_{NB}}{s_{NB}}$. Without restricting the range of parameter values, three scenarios should be distinguished: *I*, $s^*_{PL} = \widehat{s}^*_{PL}$, *II*, $s^*_{PL} = \underline{s}^*_{PL}$ and *III*, $s^*_{PL} = \overline{s}^*_{PL}$ with $\underline{s}^*_{PL} < \widehat{s}^*_{PL} < \overline{s}^*_{PL}$.[12] Figure 1 summarizes the optimal product line for the different ranges of parameter values a and $\frac{c_{NB}}{s_{NB}}$.

To facilitate the exposition of the different scenarios, we will distinguish two cases according to which the PL product faces a competitive disadvantage or benefits from a competitive advantage with respect to the NB product.

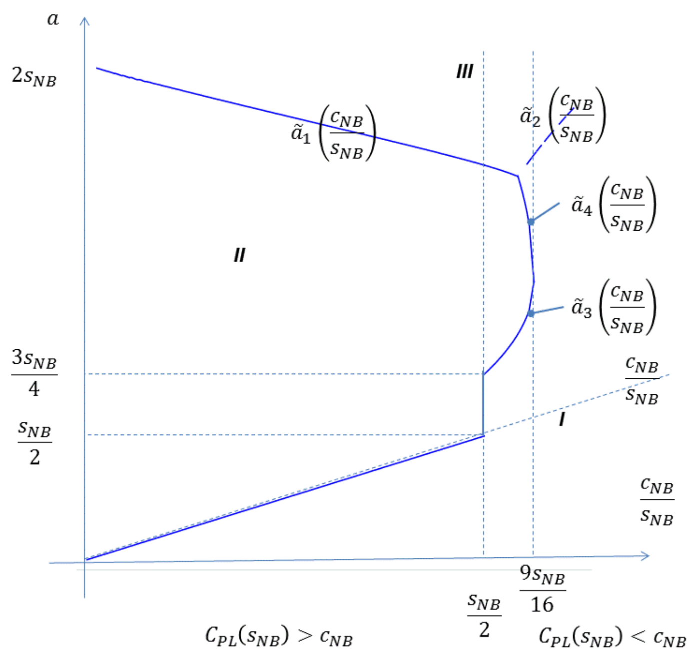

Fig. 1: Optimal product line in the benchmark case.

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[12] Critical values are given by:

$$\widehat{s}^*_{PL} = \frac{2}{3}a,\ \underline{s}^*_{PL} = \frac{3s_{NB} - \sqrt{9s^2_{NB} - 16c_{NB}}}{4}$$

$$\text{and } \overline{s}^*_{PL} = \frac{a + 2s_{NB} + \sqrt{4s^2_{NB} + a^2 - 2as_{NB} - 6c_{NB}}}{3}.$$

Conditions that define these critical values can be found in Appendix A.

In the former case, $c_{NB} \leq C_{PL}(s_{NB})$ which translates into $\frac{c_P}{s_P} \leq \frac{s_P}{2}$, the PL product faces a competitive disadvantage. If the parameter values fall into region I (i.e., if a is relatively low), the vertically integrated structure sells the PL product only $(\widehat{s}^*_{PL})$. As the market size is relatively small $(a \leq \frac{c_P}{s_P})$, the relative production cost of the NB product is too high so as to ensure a positive margin for the NB product and, only the PL product is sold. On the other hand, if the market size is very high (i.e., in region III), the vertically integrated structure sells both products, but the optimal quality of the PL product is set higher than the quality of the NB product $(\overline{s}^*_{PL} > s_P)$. As the market size is high $\left(a > \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)\right)$, there exist opportunities to provide an optimal quality of the PL higher than the quality of the NB product. Some consumers will accept paying a very high price for higher quality. Finally, if the market size falls into an intermediate region (i.e., in region II), the vertically integrated structure sells both products with the optimal quality of the PL product smaller than the quality of the NB product $(\underline{s}^*_{PL} < s_{NB})$. Here (i.e., for $\frac{c_{NB}}{s_{NB}} < a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$), the vertically integrated structure uses the PL product as a tool for market segmentation. Consumers with a high willingness to pay buy the NB product while consumers with a lower willingness to pay buy the PL product.

In the latter case, $c_{NB} > C_{PL}(s_{NB})$ which translates into $\frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$, the PL product benefits from a competitive advantage with respect to the NB product. If $\frac{c_{NB}}{s_{NB}} > \frac{9}{16}s_{NB}$, the relative production cost of the NB product is relatively high so that it will be sold only when the market size is relatively high $\left(a > \widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)\right)$. In this case (i.e., in region III), the vertically integrated structure will sell both products with the optimal quality of the PL product higher than the quality of the NB product $(\overline{s}^*_{PL} > s_{NB})$. On the other hand, if the market size is smaller $\left(a \leq \widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)\right)$, only the PL product is sold with $s^*_{PL} = \widehat{s}^*_{PL}$ (i.e., in region I). The market size is not large enough to ensure that both products are sold and it is only the PL product which is sold because it benefits from a competitive advantage. Then, we consider the range of parameters where $\frac{c_{NB}}{s_{NB}}$ is intermediate $(\frac{s_{NB}}{2} < \frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB})$, and whereby there may exist opportunities to sell both products, NB and PL, with the optimal quality of the PL product smaller than the quality of the NB product (region *II:* $\underline{s}^*_{PL} < s_{NB}$). This case arises, even if the PL product benefits from a competitive advantage. We obtain this case when the market size falls into an intermediate region (for a such that $\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq Min\left\{\widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right), \widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right)\right\}$). The vertically integrated structure uses the PL product as a tool for market segmentation by setting the optimal quality of the PL product smaller than the quality of the NB product. By contrast, if $a \leq \widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right)$ (i.e., region I), only the PL product is sold ($\widehat{s}^*_{PL}$) and if $a > Min\left\{\widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right), \widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right)\right\}$ (i.e., in region III), both products are sold and the optimal quality of the PL product is set higher than the quality of the NB product ($\overline{s}^*_{PL} > s_{NB}$). In the former case, the market size is not large enough to ensure that both products are sold and, only the PL product will be sold as the NB product faces a competitive disadvantage. In the latter case, the vertically integrated structure uses the NB product as a tool for market segmentation, and the optimal quality of the PL product is set higher than the quality of the NB product.[13] The range of product quality is due to the competitive advantage of the PL product compared to the NB product ($c_{NB} > C_{PL}(s_{NB})$).

We summarize our results in Proposition 1.

Proposition 1 *Depending on the range of parameter values (see Figure 1 for details), the product line of a fully vertically integrated industry is given by:*

- Region I, $s^*_{PL} = \widehat{s}^*_{PL}$, the PL product is sold only;

- Region II, $s^*_{PL} = \underline{s}^*_{PL}$, both PL and NB products are sold with $\underline{s}^*_{PL} < s_{NB}$; and

- Region III, $s^*_{PL} = \overline{s}^*_{PL}$, both PL and NB products are sold, but with $\overline{s}^*_{PL} > s_{NB}$.

We have:

$$\widehat{s}^*_{PL} = \frac{2}{3}a,\ \underline{s}^*_{PL} = \frac{3s_{NB} - \sqrt{9s_{NB}^2 - 16c_{NB}}}{4}$$
$$\textit{and } \overline{s}^*_{PL} = \frac{a + 2s_{NB} + \sqrt{4s_{NB}^2 + a^2 - 2as_{NB} - 6c_{NB}}}{3}.$$

Proof. See Appendix A.

Threshold values in a are detailed in the Appendix. ■

In the following, we will focus on the set of parameter values corresponding to the region II: the vertically integrated structure uses the PL product as a tool for market

[13] An intermediate area also arises in this latter case, where $Min\left\{\widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right), \widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right)\right\} < a < \widetilde{a}_2$ for which, PL product is sold only (region I, $s^*_{PL} = \widehat{s}^*_{PL}$).

segmentation by setting the optimal quality of the PL product smaller than the quality of the NB product.[14] If the motivation for PL products is to segment the market, we should expect to have an equilibrium where the quality of the PL product chosen by the retailer is smaller than the quality of NB product. However, as we will see, the choice of the retailer fundamentally changes the equilibrium product line.

4 Equilibrium product line

We solve backwards the previous three-stage game: the retailer chooses the quality level of the PL product, the supplier of the NB product proposes a two-part tariff which is either accepted or rejected by the retailer and, lastly, the retailer sets the retail prices.

At stage three, the maximization problem of the retailer consists of setting p_{NB} and p_{PL} to maximize its profits:

$$\pi_D\left(p_{PL}, p_{NB}, w, s_{PL}, s_{NB}\right) - F,$$

where F represents the fixed fee that the retailer pays to the supplier. The maximization problem leads to $p^e_{NB}\left(w, s_{PL}, s_{NB}\right), p^e_{PL}\left(w, s_{PL}, s_{NB}\right)$ and the retailer obtains $\pi_D\left(p^e_{PL}\left(w,.\right), p^e_{NB}\left(w,.\right), w, s_{PL}, s_{NB}\right) - F$.

Then, at stage two, the two-part tariff set by the supplier can be obtained from the following maximization problem:

$$\begin{aligned} &Max_{w,F}\left(w - c_{NB}\right) D_{NB}\left(p^e_{PL}\left(w,.\right), p^e_{NB}\left(w,.\right), s_{PL}, s_{NB}\right) + F \\ &\qquad s.t. \qquad \pi_D\left(p^e_{PL}\left(w,.\right), p^e_{NB}\left(w,.\right), w, s_{PL}, s_{NB}\right) - F \geq \pi_D\left(p^e_{PL}\left(s_{PL}\right), +\infty, s_{PL}\right), \end{aligned}$$

where $\pi_D\left(p^e_{PL}\left(s_{PL}\right), +\infty, s_{PL}\right)$ represents the disagreement payoff of the retailer. This yields the familiar solution, whereby the participation constraint of the retailer holds

[14] We will thus focus on the range of parameters for which:

If $\frac{c_{NB}}{s_{NB}} < \frac{s_{NB}}{2}$, we have a such that $\frac{c_{NB}}{s_{NB}} < a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$;

If $\frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$, we have a such that $\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq Min\left\{\widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right), \widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right)\right\}$ (with $\frac{c_{NB}}{s_{NB}} < \frac{9}{16}s_{NB}$).

with equality and the fixed fee that the retailer pays to the supplier is:

$$F = \pi_D \left(p^e_{PL}(w,.), p^e_{NB}(w,.), w, s_{PL}, s_{NB}\right) - \pi_D \left(p^e_{PL}(s_{PL}), +\infty, s_{PL}\right).$$

The maximization problem becomes:

$$\begin{aligned} &Max_w \,(w - c_{NB})\, D_{NB}\left(p^e_{PL}(w,.), p^e_{NB}(w,.), s_{PL}, s_{NB}\right) \\ &\quad + \pi_D \left(p^e_{PL}(w,.), p^e_{NB}(w,.), w, s_{PL}, s_{NB}\right) - \pi_D \left(p^e_{PL}(s_{PL}), +\infty, s_{PL}\right), \end{aligned}$$

which is equivalent to maximizing the joint-profits of the NB manufacturer and the retailer because the retailer's disagreement payoff $\pi_D \left(p^e_{PL}(s_{PL}), +\infty, s_{PL}\right)$ does not depend on the wholesale price. Using the envelope theorem, the wholesale price is set to the marginal cost of production of the NB product, that is, $w = c_{NB}$.

Finally, at stage one, the retailer chooses the quality of the PL product to maximize its profits which is equal to its disagreement payoff:

$$Max_{s_{PL}} \pi_D \left(p^e_{PL}(s_{PL}), +\infty, s_{PL}\right).$$

Solving the maximization problem above leads to $s^{**}_{PL} = \frac{2}{3}a$. In any case, the quality s^{**}_{PL} of the PL product is chosen higher than the optimal quality s^*_{PL} (with $s^*_{PL} = \underline{s}^*_{PL}$, maximizing industry profits). In fact, the retailer chooses the quality of its PL product in order to strengthen its bargaining power, instead of segmenting the market. We will show that PL positioning structurally changes the equilibrium product line. Depending on parameter values, four regions should be distinguished:

- Region A, both products are sold, and the product line is such that $s^{**}_{PL} < s_{NB}$: (s^{**}_{PL}, s_{NB}) with $s^{**}_{PL} < s_{NB}$;

- Region B, the demand for the PL product is zero, and only the NB product is sold: $(\varnothing, s_{NB})$;

- Region C, both products are sold, but the product line is such that $s^{**}_{PL} > s_{NB}$: (s^{**}_{PL}, s_{NB}) with $s^{**}_{PL} > s_{NB}$; and

- Region D, the demand for the NB product is zero, and only the PL product is sold: $(s^{**}_{PL}, \varnothing)$.

Figure 2 below summarizes the equilibrium product line for the different ranges of parameter values. We distinguish between the case where the retailer faces a competitive disadvantage ($\frac{c_{NB}}{s_{NB}} \leq \frac{s_{NB}}{2}$) and the case in which the retailer benefits from a competitive advantage ($\frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$).

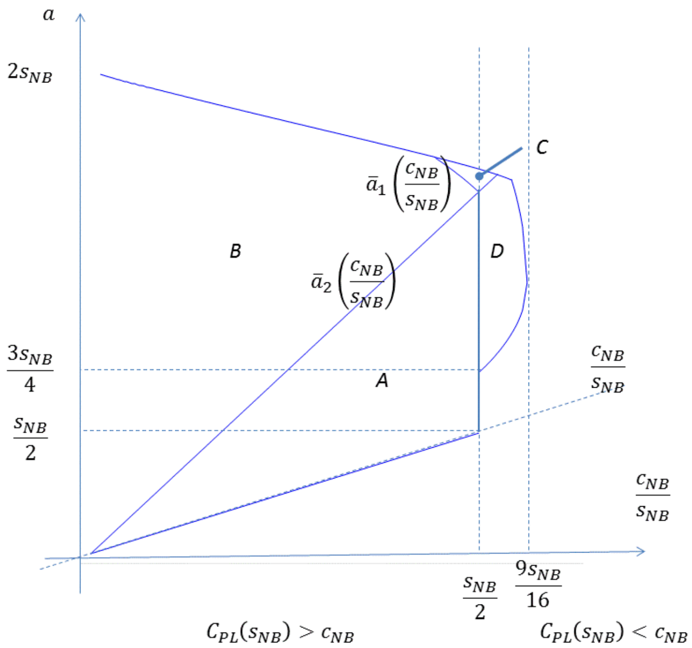

Fig. 2: PL positioning and product line.

In the former case, if the parameter values fall into region A (i.e., if a is relatively low: $a \leq \bar{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) = 3\frac{c_{NB}}{s_{NB}}$), both products are sold. The quality of the PL product is closer to the quality of the NB product (compared to the solution which maximizes industry surplus), but both qualities are sold at the equilibrium. By contrast, if a is higher: $a > \bar{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) = \frac{3\left(3s_{NB}+\sqrt{9s_{NB}^2-16c_{NB}}\right)}{8}$, only the NB product is sold (region B, $\bar{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \bar{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$) or both products are sold, with $s_{PL}^{**} > s_{NB}$ (region C, i.e., $a > \bar{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$). In the former region, there will exist opportunities to provide a smaller quality of the PL product. However, as the retailer does not internalize the joint-profits with the NB manufacturer and only considers its disagreement payoff, the demand for the PL product is zero at the end. This result is related to the finiteness property as mentioned in the Introduction (Gabszewicz and Thisse, 1979; Shaked and Sutton, 1983). In vertically differentiated markets, the number of products with a positive demand depends on the degree of consumer heterogeneity. When the two qualities are close, which is the case in region B, the more efficient quality preempts the less efficient quality. As the retailer faces a competitive disadvantage, the less efficient quality is the PL product, and the PL product is not sold at equilibrium. PL positioning structurally changes the retailer's product line.[15] In the latter region, the relative cost of the PL product is close to the relative cost of the NB product. At the equilibrium, the demand for the PL product becomes positive, but now the equilibrium product line is such that $s_{PL}^{**} > s_{NB}$.

In the latter case $\frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$, the retailer benefits from a competitive advantage, whereby the demand for NB is zero if a is relatively low (region D, i.e. $a \leq \overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$). As above, this result is due to the finiteness property. The two qualities are close and the more efficient quality preempts the less efficient quality. As the retailer now benefits from a competitive advantage, it is the NB product which is not sold at equilibrium. The result is that the supplier of the NB product is denied access to the retail market, which was not the case in the fully integrated vertical industry. PL positioning implies that the NB manufacturer is preempted from the market. On other hand, if the market size is relatively high and the relative cost of the PL product is close to the relative cost of the NB product, the demand for the NB product now becomes positive. The equilibrium product line is such that $s_{PL}^{**} > s_{NB}$ (region C, i.e. $a > \overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$). In this region, the PL product is a premium brand and the NB product is used to segment the market.

We summarize results in Proposition 2.

Proposition 2 *Assume parameter values are in region II, depending on the range of parameter values (see Figure 2, for details), equilibrium product line with* $s_{PL}^{**} = \frac{2}{3}a > s_{PL}^{*}$ *is given by:*

- Region A, both products are sold, and the product line is such that $s_{PL}^{**} < s_{NB}$*:* (s_{PL}^{**}, s_{NB}) *with* $s_{PL}^{**} < s_{NB}$*;*

- Region B, the demand for the PL product is zero, and only the NB product is sold: $(\oslash, s_{NB})$*;*

[15] See also Bacchiega and Bonroy (2015) for a use of this property in vertical relationships in a different context.

- Region C, both products are sold, and the product line is such that $s_{PL}^{**} > s_{NB}$*:* (s_{PL}^{**}, s_{NB}) *with* $s_{PL}^{**} > s_{NB}$*; and*

- Region D, the demand for the NB product is zero, and only the PL product is sold: $(s_{PL}^{**}, \oslash)$.

Proof. See Appendix B. ■

The supplier and the retailer face a coordination problem. Instead of considering industry surplus, the retailer maximizes its outside option so as to strengthen its bargaining position, which results in a higher quality of the PL product. Quality inefficiency implies that total demand in the category is smaller. The inefficiency we highlight is due to the timing of the game we have chosen. However, this timing is familiar as contracting decisions present a lower degree of irreversibility than quality choices.

Another essential feature of PL products is that their characteristics are fixed by retailers and not by manufacturers. Suppose, instead, that the quality decision is taken by another supplier in stage 1, and the NB manufacturer and this supplier offer two-part tariffs in stage 2 (offers are public and are made simultaneously). The quality chosen by this supplier now maximizes industry surplus. To understand the difference between the two games, it is straightforward to show that contracts are still efficient because of two-part tariffs and the supplier now considers the incremental contribution of its good to the surplus of product category. Let $\Pi_I\left(C_{PL}\left(s_{PL}\right), c_{NB}, s_{PL}, s_{NB}\right) - \Pi_I\left(+\infty, c_{NB}, \oslash, s_{NB}\right)$ denotes its incremental contribution to the product category. In maximizing its incremental contribution, the supplier maximizes industry surplus as $\Pi_I\left(+\infty, c_{NB}, \oslash, s_{NB}\right)$, which is the monopoly profit related to the NB product, independent of s_{PL}. By contrast, the retailer in positioning its PL product considers $\Pi_I\left(C_{PL}\left(s_{PL}\right), +\infty, s_{PL}, \oslash\right)$ alone, which is its outside option.[16] The coordination problem we highlight arises as it is the retailer who sets the characteristics of PL products. As previously seen, PL positioning structurally changes product lines.

In our setting, total demand at equilibrium decreases due to PL positioning but the retail price of the NB product is unchanged. We now turn to the analysis of consumer surplus and total welfare.

Consumer surplus and welfare analysis

[16] See also Scott-Morton and Zettelmeyer (2004) for similar point.

As there is no double marginalization at the equilibrium of this game, the results in terms of consumer surplus and welfare will only depend on the comparison of levels of the quality for PL product between the vertically integrated structure and the situation where the retailer chooses the quality. We denote by $CS(s_{NB}, s_{PL})$ the consumer surplus and by $W(s_{NB}, s_{PL})$ the total welfare. The consumer surplus (with $s_i < s_j$) is given by:

$$CS(s_i, s_j) = \int_{\frac{p_j^e}{s_j}}^{\frac{p_i^e - p_j^e}{s_i - s_j}} \left(\theta s_j - p_j^e\right) d\theta + \int_{\frac{p_i^e - p_j^e}{s_i - s_j}}^{a} \left(\theta s_i - p_i^e\right) d\theta,$$

and the total welfare by:

$$W(s_i, s_j) = \Pi_I(s_i, s_j) + CS(s_i, s_j),$$

with $\Pi_I(s_i, s_j)$ representing industry surplus,

$$\Pi_I(s_i, s_j) = \int_{\frac{p_j^e}{s_j}}^{\frac{p_i^e - p_j^e}{s_i - s_j}} \left(p_j^e - c_j\right) d\theta + \int_{\frac{p_i^e - p_j^e}{s_i - s_j}}^{a} \left(p_i^e - c_i\right) d\theta.$$

Simple calculations show that $\Pi_I(s_i, s_j) = 2CS(s_i, s_j)$. An implication of this observation is that the quality of the PL product, which maximizes the industry surplus (i.e., the vertically integrated structure), maximizes the total welfare. Eventually, the quality of the PL product chosen by the retailer decreases the total welfare. The analysis above is summarized in the following proposition.

Proposition 3 *Quality choice of the PL product by the retailer is detrimental to the consumer surplus and the total welfare.*

Proof. See the text above. ■

As noted in the Introduction, some economists have argued that PLs would enhance consumer surplus and total welfare. While such an argument may apply when the double marginalization problem between NB producers and retailers applies, our analysis instead shows that the quality choice of PL products by the retailer is always detrimental to consumer surplus and total welfare. Our results are different because the double marginalization problem is avoided when two-part tariffs are used by suppliers.

5 Discussion

We have shown that the low differentiation between PL products and NB products can be explained by the fact that retailers use PL products as a bargaining tool with NB manufacturers. Suppliers can adopt several strategies by which to respond to this situation. In the following subsection, we discuss these strategies. Moreover, while we have shown that inefficient PL positioning arises when the bargaining power of the NB is large, we will show that this inefficiency decreases when the bargaining power of the NB manufacturer decreases. This issue is discussed in the latter subsection.

5.1 PL positioning and manufacturer counterstrategies

It is straightforward to show that the solution to the coordination problem we focus on above is based on the inversion of the order of the steps which are, on the one hand, PL positioning and, on the other hand, contract offers.

We now assume the following timing in place of the previous one. The NB manufacturer proposes a two-part tariff that the retailer accepts or rejects, the retailer chooses the quality of PL product and, finally, sets the retail prices.

The quality chosen by the retailer is thus optimal from the point of view of industry surplus.[17] The objectives of the NB manufacturer and the retailer are now aligned: once the contract is accepted, the distributor chooses its PL quality so as to maximize industry surplus. The profit of the retailer is unchanged compared to the previous game and the profit of the supplier is larger. While the retailer still obtains $\Pi_I\left(C_{PL}\left(s_{PL}^{**}\right), +\infty, s_{PL}^{**}, \oslash\right)$, the NB manufacturer profits are now:

$$\Pi_I\left(C_{PL}\left(s_{PL}^{*}\right), c_{NB}, s_{PL}^{*}, s_{NB}\right) - \Pi_I\left(C_{PL}\left(s_{PL}^{**}\right), +\infty, s_{PL}^{**}, \oslash\right),$$

which are larger than:

$$\Pi_I\left(C_{PL}\left(s_{PL}^{**}\right), c_{NB}, s_{PL}^{**}, s_{NB}\right) - \Pi_I\left(C_{PL}\left(s_{PL}^{**}\right), +\infty, s_{PL}^{**}, \oslash\right),$$

as $\Pi_I\left(C_{PL}\left(s_{PL}^{*}\right), c_{NB}, s_{PL}^{*}, s_{NB}\right) > \Pi_I\left(C_{PL}\left(s_{PL}^{**}\right), c_{NB}, s_{PL}^{**}, s_{NB}\right)$ by definition. The problem of coordination we discussed earlier is harmful to the supplier alone.

[17] A formal proof of the result is available upon request.

While the order of the stages we consider initially takes into account the PL process, the reversal of the steps presented shows certain partnership policies that some suppliers have put in place. In order to reestablish the optimal segmentation of the demand in the product category, some suppliers have developed two types of products: first, a type of product that is considered innovative and is supported by major advertising campaigns, and second, lower quality products which have a reduced sales potential. The two categories of products are sold under two different brands, the first under NB and the second under PL. Listing the entire product range implies leaving the retailer its outside option which is still given by the profit it would make, in the absence of these products from the NB manufacturer. This supplier-retailer partnership can solve the quality inefficiency highlighted above.[18] Other forms of partnerships between suppliers and retailers can be reinterpreted to solve this coordination problem. Retail category management for example can be seen as a tool to efficiently segment product category. Depending on its bargaining power, the retailer can adopt such management to increase the profits of a given product category and then increase its profits if its bargaining power is sufficiently large. By leaving one supplier which has the management of the product category, the retailer segments the market.

Another key feature in the retailer's quality choice of PL product is the competition between NB manufacturers. The following subsection shows how fierce competition between NB manufacturers may in return lead to optimal segmentation in the product category. The retailer will segment the market in positioning PL product in place of strengthening its bargaining position vis-à-vis NB manufacturers.

5.2 PL positioning and NB manufacturers' competition

We take up the initial structure of the game, with the difference that the NB upstream sector is now made up of two homogeneous producers for the NB product instead of one: P_1 and P_2 with $s_{NB1} = s_{NB1} = s_{NB}$. The cost structure considered for these manufacturers is as follows: while firm 1, that is, P_1, produces at cost c_{NB1}, firm 2, that is, P_2, produces at a higher cost ($c_{NB2} \geq c_{NB1}$). The cost difference between firms 1 and 2 can be interpreted as the level of competition between NB manufacturers. If the

[18] Similar insights have been addressed by Bergès and Bouamra-Mechemache (2012) in another context. In the case of excess production capacity, the manufacturer can use its excess capacity by supplying the retailer with a PL product and thus facilitate the entire product range listing.

difference is zero, the firms are in perfect competition; by contrast, when the difference is large, firm 2 does not constitute an alternative to the efficient NB manufacturer (firm 1).[19]

Consider now the following game: in the first stage, the retailer chooses the quality of PL product to be produced by a competitive fringe whose marginal cost of production is increasing and convex in quality; in stage two, P_1 and P_2 make offers in two-part tariffs, the retailer chooses one of these offers; and finally, in stage three, the retailer sets retail prices.

As previously, contracts proposed by the NB manufacturers are efficient from the point of view of the vertical structure for a given level of quality for PL product (wholesale prices are respectively equal to marginal costs).[20] The retailer chooses the efficient manufacturer, the one whose cost is lower (i.e. P_1). Then, the quality chosen by the retailer corresponds to the quality that maximizes the profits of the vertical structure formed by the retailer and the least efficient manufacturer (P_2) in place of the more efficient manufacturer (P_1). Let $\Pi_I\left(C_{PL}\left(s_{PL}\right), c_{NB2}, s_{PL}, s_{NB}\right)$ denote the profits of the vertical structure formed by the retailer and the least efficient manufacturer (P_2). The outside option of the retailer is now given by $\Pi_I\left(C_{PL}\left(s_{PL}\right), c_{NB2}, s_{PL}, s_{NB}\right)$ instead of $\Pi_I\left(C_{PL}\left(s_{PL}\right), +\infty, s_{PL}, \oslash\right)$ which were the profits it would obtain without an alternative NB manufacturer. Simple comparative statics show that the quality chosen by the retailer is an increasing function in the cost of the least efficient manufacturer (P_2) and the retailer's profits decrease in this.[21] In other words, when the cost difference between NB manufacturers decreases, PL quality decreases, approaching the quality which is chosen for an optimal segmentation in the product category. The retailer's profits increase as this cost difference narrows.[22]

[19] Another possible modeling is to consider a Generalized Nash Negotiation between the NB manufacturer and the retailer. Both approaches lead to similar results.

[20] A formal proof of the result is available upon request.

[21] The profits of the retailer are given $\Pi_I\left(C_{PL}\left(s_{PL}\right), c_{NB2}, s_{PL}, s_{NB}\right)$ with s_{PL} which maximizes these profits. By using F.O.C in s_{PL}, we have $\frac{\partial s_{PL}}{\partial c_{NB2}} = -\frac{-\partial D_{NB}/\partial s_{PL}}{\partial^2 \Pi_I/\partial s_{PL}^2}$ which is positive with $\partial D_{NB}/\partial s_{PL} < 0$, at least if $s_{PL} < s_{NB}$. Moreover, by totally differentiating retailer's profits, we obtain $\frac{\partial \Pi_I}{\partial c_{NB2}} = -D_{NB}(.) < 0$.

[22] If we have a relationship between NB manufacturers competition and differentiation within the product category, we can also address the issue of the introduction of PL products. Let us now suppose that the introduction decision requires expenditures of a fixed cost, which is independent of the quality. It is thus possible to show that the retailer's gain in introducing PL product (from which he will choose the quality) is an increasing function of the difference in production costs between NB manufacturers.

6 Conclusion

We have studied a model of quality choice for PL products. The benchmark case helps us to determine the environment in which PL products could be used to segment the market. We have shown that the two dimensions which are the segmentation of the market and strengthening the bargaining power of the retailer play in opposite directions. More specifically, while the segmentation of the market suggests the differentiation of the NB product and the PL product, the quality choice of the PL product made by the retailer mimics the quality of the NB product. The quality differentiation between the PL product and the NB product is smaller: the retailer chooses a quality which raises its disagreement payoff and enables it to receive a larger share of the joint-profit with the NB supplier.

Furthermore, we have determined the equilibrium retailer's product line in an environment in which the PL product would be used to segment the market. We have found that the choice of the retailer fundamentally changes the equilibrium product line. PL products with higher quality than NB products may emerge. But, more importantly, we have demonstrated that the result may in some cases be that PL products are sold only, and that the demand for NB products is zero. In other cases, we have shown that PL products are not sold in the category.

Moreover, while the focus is often on the impact of PL products on NB products' retail prices, our analysis suggests that the impact is zero. However, total demand is smaller due to less differentiation in quality, which results in lower consumer surplus and lower total welfare.

The retailer and the NB supplier face a coordination problem, which can be avoided if the supplier can propose a contract before PL product positioning. Optimal product lines can also be restored if NB suppliers are in fierce competition. In both cases, the PL product is thus used to segment the market instead of strengthening the bargaining

Let $\Pi_I\left(C_{PL}\left(s_{PL}\right), c_{NB2}, s_{PL}, s_{NB}\right) - \Pi_I\left(+\infty, c_{NB2}, \oslash, s_{NB}\right)$ denote the retailer's gain in introducing the PL product. Simple calculations show that this gain increases in the difference in production costs between NB manufacturers $\frac{\partial[\Pi_I(C_{PL}(s_{PL}),.)-\Pi_I(+\infty,.)]}{\partial c_{NB2}} = -\left[D_{NB}\left(C_{PL}\left(s_{PL}\right),.\right) - D_{NB}\left(+\infty,.\right)\right] > 0$ with $\left[D_{NB}\left(C_{PL}\left(s_{PL}\right),.\right) - D_{NB}\left(+\infty,.\right)\right] < 0$ because of imperfect substitution between PL and NB products. Understanding why PLs are introduced in some product categories and not in others could be related to the degree of competition between NB manufacturers. While PLs would be expected in categories with little competition between NB manufacturers, they would be absent in categories with fierce competition between NB manufacturers. If the reasoning holds in our setting, other dimensions need to be considered, as NB products are not often homogeneous goods.

power of the retailer.

One remaining issue not addressed here is that retailers compete and that the PL product introduction may play a role in retailers' competition. As cited in the Introduction, some papers have investigated this question, however, the competition between retailers is far from simple. In practice, many customers engage in multi-stop shopping and rely on several retailers in order to fulfill their needs. While some customers are one-stop shoppers, other customers are multi-stop shoppers. PL products play a role in the shopping behavior of consumers: for example, we can assume that consumers who buy PL products are more often one-stop shoppers than multi-stop shoppers. There is now a literature on competitive multi-product pricing using multi-stop shopping and one-stop shopping behavior (see for example, Chen and Rey, 2012 and Johnson, 2016). Using these frameworks as building blocks to revisit PL positioning when retailers compete would be interesting, however, we leave this task for further investigation.[23]

[23] Some authors have used consumer shopping costs to revisit vertical relationships issues. See Caprice and von Schlippenbach (2013), Johansen and Nilssen (2016) and Caprice and Shekhar (2017).

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Appendix

A Proof of Proposition 1

We determine the quality of PL which is optimal from the point of view of industry surplus.

In the case, $s_{NB} - s_{PL} > 0$, demand functions for s_{NB} and s_{PL} will respectively be given by:

$$D_{NB} = \left(a - \frac{p^e_{NB} - p^e_{PL}}{s_{NB} - s_{PL}} \right) > 0 \text{ and } D_{PL} = \left(\frac{p^e_{NB} - p^e_{PL}}{s_{NB} - s_{PL}} - \frac{p^e_{PL}}{s_{PL}} \right) > 0,$$

with $p^e_{NB} = \frac{1}{2}(c_{NB} + as_{NB})$ and $p^e_{PL} = \frac{1}{2}(C_{PL}(s_{PL}) + as_{PL})$ and we will look for the solution in s_D of the following function:

$$\Pi_I \left(p^e_{PL}, p^e_{NB}, s_{NB}, s_{PL}\right) = \left(p^e_{NB} - c_{NB}\right) D_{NB} + \left(p^e_{PL} - c_{PL}(s_{PL})\right) D_{PL}.$$

However, we do not restrict attention to the situation $s_{NB} - s_{PL} > 0$ even if, at the end, we will focus on this scenario.

We distinguish two cases according to which the retailer faces a competitive disadvantage (Case 1: $C_{PL}(s_{NB}) \geq c_{NB}$) or benefits from a competitive advantage (Case 2: $C_{PL}(s_{NB}) > c_{NB}$).

Case 1: $C_{PL}(s_{NB}) \geq c_{NB}$,

The retailer faces a competitive disadvantage: $\frac{c_{NB}}{s_{NB}} \leq \frac{s_{NB}}{2}$.

We have to define several threshold values in s_{PL} to explicit the demand functions. Let $\widehat{s}_{PL}$, $\widetilde{s}_{PL}$ and $\widetilde{\widetilde{s}}_{PL}$ denote these threshold values:

$$\widehat{s}_{PL} < s_{NB} < \widetilde{s}_{PL} < \widetilde{\widetilde{s}}_{PL}.$$

The demand for the low quality is positive if $s_{PL} < \widehat{s}_{PL}$; $\widehat{s}_{PL}$ is given by solving $\frac{p^e_{NB} - p^e_{PL}}{s_{NB} - s_{PL}} - \frac{p^e_{PL}}{s_{PL}} = 0$ for s_{PL}. The result is $\widehat{s}_{PL} = \frac{2c_{NB}}{s_{NB}}$. Now, assume that $s_{PL} > s_{NB}$, there exist values of s_{PL} according to which the demand for s_{PL} is positive if $Min_{s_{PL} > s_{NB}} \frac{p^e_{PL} - p^e_{NB}}{s_{PL} - s_{NB}} < a$. Let $\widehat{a}_1 \left(\frac{c_{NB}}{s_{NB}}\right)$ denote the threshold value in a such that $Min_{s_{PL} > s_{NB}} \frac{p^e_{PL} - p^e_{NB}}{s_{PL} - s_{NB}} = a$

and let $\widehat{\widehat{s}}_{PL} = Arg\min \frac{p^e_{PL}-p^e_{NB}}{s_{PL}-s_{NB}}$ denote the corresponding value in quality. We obtain $\widehat{\widehat{s}}_{PL} = s_{NB} + \sqrt{s_{NB} - 2c_{NB}}$ and $\widehat{a}_1\left(\frac{c_{NB}}{s_{NB}}\right) = \left.\frac{p^e_{PL}-p^e_{NB}}{s_{PL}-s_{NB}}\right|_{s_{PL}=\widehat{\widehat{s}}_{PL}}$. The result is:

- if $a \leq \widehat{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$, the demand for s_{PL} is zero for any s_{PL} such that $s_{PL} > s_{NB}$;

- if $a > \widehat{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$, there exist values of s_{PL} such that, for $s_{PL} > s_{NB}$, the demand for s_{PL} is positive. In particular, if $s_{PL} \in \left(\widetilde{s}_{PL}, \widetilde{\widetilde{s}}_{PL}\right)$ the demand is positive. $\widetilde{s}_{PL}$ and $\widetilde{\widetilde{s}}_{PL}$ are obtained by solving $\frac{p^e_{PL}-p^e_{NB}}{s_{PL}-s_{NB}} = a$ for s_{PL} in case $a > \widehat{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$, leading to:

$$\widetilde{s}_{PL} = a - \sqrt{a^2 + 2c_{NB} - 2as_{NB}} \qquad \text{and} \qquad \widetilde{\widetilde{s}}_{PL} = a + \sqrt{a^2 + 2c_{NB} - 2as_{NB}}.$$

The function, we have to maximize is locally concave in s_{PL}.

- 1.1: $a \leq \frac{c_{NB}}{s_{NB}}$.

The demand for NB product is zero. The optimal quality for PL product solves:

$$\left[p^e_{PL} - C_{PL}(s_{PL})\right] \frac{\partial D_{PL}(., s_{PL})}{\partial s_{PL}} = \frac{\partial C_{PL}(s_{PL})}{\partial s_{PL}} D_{PL}(p^e_{PL}, +\infty, s_{PL})$$

with $D_{PL}(p^e_{PL}, +\infty, s_{PL}) = a - \frac{p^e_{PL}}{s_{PL}}$, which results in $s^*_{PL} = \widehat{s}^*_{PL}$ with $\widehat{s}^*_{PL} = \frac{2}{3}a$. Industry profits are given by: $\pi_I(\widehat{s}^*_{PL}, \varnothing) = \frac{2}{27}a^3$.

- 1.2: $\frac{c_{NB}}{s_{NB}} < a \leq \widehat{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$.

The demand for PL product is zero if $s_{PL} > s_{NB}$. The optimal quality for PL product solves:

$$\left[p^e_{PL} - C_{PL}(s_{PL})\right] \frac{\partial D_{PL}(., s_{PL}, s_{NB})}{\partial s_{PL}} + \left[p^e_{NB} - c_{NB}\right] \frac{\partial D_{NB}(., s_{PL}, s_{NB})}{\partial s_{PL}} = \frac{\partial C_{PL}(s_{PL})}{\partial s_{PL}} D_{PL}(p^e_{PL}, p^e_{NB}, s_{PL}, s_{NB})$$

with $D_{NB}(p^e_{PL}, p^e_{NB}, s_{PL}, s_{NB}) = a - \frac{p^e_{NB}-p^e_{PL}}{s_{NB}-s_{PL}}$ and $D_{PL}(p^e_{PL}, p^e_{NB}, s_{PL}, s_{NB}) = \frac{p^e_{NB}-p^e_{PL}}{s_{NB}-s_{PL}} - \frac{p^e_{PL}}{s_{PL}}$, which results in $s^*_{PL} = \underline{s}^*_{PL}$ where $\underline{s}^*_{PL} = \frac{3s_{NB}-\sqrt{9s^2_{NB}-16c_{NB}}}{4}$ leads to following industry profits:

$$\pi_I(\underline{s}^*_{PL}, s_{NB}) = \frac{4c^2_{NB} + s_{NB}\left(\underline{s}^{*3}_{PL} + 4a^2(s_{NB} - \underline{s}^*_{PL})\right) - 4s_{NB}\left(\underline{s}^{*2}_{PL} + 2a(s_{NB} - \underline{s}^*_{PL})\right)}{16(s_{NB} - \underline{s}^*_{PL})}.$$

- 1.3: $a > \widehat{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$.

There exists an interval for $s_{PL} > s_{NB}$ for which the demand in PL product is positive, that is, when $s_{PL} \in \left(\widetilde{s}_{PL}, \widetilde{\widetilde{s}}_{PL}\right)$. Two local solutions have to be compared: $\underline{s}^*_{PL} < s_{NB}$ from previous analysis and $\overline{s}^*_{PL} > s_{NB}$ that we will define. Let $\overline{s}^*_{PL}$ denote the new local solution which is obtained by solving:

$$\begin{aligned}\left[p^e_{PL} - C_{PL}(s_{PL})\right]\frac{\partial D_{PL}(., s_{PL}, s_{NB})}{\partial s_{PL}} + \left[p^e_{NB} - c_{NB}\right]\frac{\partial D_{NB}(., s_{PL}, s_{NB})}{\partial s_{PL}} \\ = \frac{\partial C_{PL}(s_{PL})}{\partial s_{PL}} D_{PL}\left(p^e_{PL}, p^e_{NB}, s_{PL}, s_{NB}\right)\end{aligned}$$

with $D_{PL}\left(p^e_{PL}, p^e_{NB}, s_{PL}, s_{NB}\right) = a - \frac{p^e_{PL} - p^e_{NB}}{s_{PL} - s_{NB}}$ and $D_{NB}\left(p^e_{PL}, p^e_{NB}, s_{PL}, s_{NB}\right) = \frac{p^e_{PL} - p^e_{NB}}{s_{PL} - s_{NB}} - \frac{p^e_{NB}}{sNB}$ for $s_{PL} \in \left(\widetilde{s}_{PL}, \widetilde{\widetilde{s}}_{PL}\right)$. $\overline{s}^*_{PL}$ is given by $\overline{s}^*_{PL} = \frac{a + 2s_{NB} + \sqrt{4s^2_{NB} + a^2 - 2as_{NB} - 6c_{NB}}}{3}$ which results in following industry profits:

$$\pi_I\left(\overline{s}^*_{PL}, s_{NB}\right) = \frac{\overline{s}^*_{PL}\left(4c^2_{NB} - 4c_{NB}\overline{s}^*_{PL}s_{NB} + s_{NB}\left(\overline{s}^{*3}_{PL} + 4a^2\left(\overline{s}^*_{PL} - s_{NB}\right) - 4a\overline{s}^*_{PL}\left(\overline{s}^*_{PL} - s_{NB}\right)\right)\right)}{16s_{NB}\left(\overline{s}^*_{PL} - s_{NB}\right)}.$$

The comparison of $\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right)$ and $\pi_I\left(\overline{s}^*_{PL}, s_{NB}\right)$ leads to threshold value in a. Let $\widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$ denote this value, such that:

$$\begin{aligned} &\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right) \geq \pi_I\left(\overline{s}^*_{PL}, s_{NB}\right) \text{ if } \widehat{a}_1\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right), \\ \text{and } &\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right) < \pi_I\left(\overline{s}^*_{PL}, s_{NB}\right) \text{ if } a > \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right).\end{aligned}$$

We thus obtain: $s^*_{PL} = \underline{s}^*_{PL}$ if $\widehat{a}_1 < a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$ and $s^*_{PL} = \overline{s}^*_{PL}$ if $a > \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$.

To sum up, we will then focus on $\frac{c_{NB}}{s_{NB}} < a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$ such that $s^*_{PL} = \underline{s}^*_{PL}$, which corresponds to the situation in which both products, with $s_{PL} < s_{NB}$ are sold when we consider the point of view of industry surplus; the corresponding optimal quality for the low quality product is given by $s^*_{PL} = \underline{s}^*_{PL}$.

Now, we consider the case where the retailer, instead of facing a competitive disadvantage benefits from a competitive advantage (Case 2: $C_{PL}(s_{NB}) < c_{NB}$).

Case 2: $C_D(s_{NB}) < c_{NB}$,

The retailer benefits from a competitive advantage: $\frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$.

As previously, we have to define several threshold values in s_{PL} to explicit demand functions. Let $\widetilde{s}_{PL} = a - \sqrt{a^2 + 2c_{NB} - 2as_{NB}}$ and $\widehat{s}_{PL} = \frac{2c_{NB}}{s_{NB}}$ denote these threshold values; we have $\widetilde{s}_{PL} < s_{NB} < \widehat{s}_{PL}$ as the retailer now benefits from a competitive advantage. $\widetilde{s}_{PL}$ is obtained by solving $\frac{p^e_{NB} - p^e_{PL}}{s_{NB} - s_{PL}} = a$ for s_{PL}. The high quality good (i.e. NB product) receives zero demand if $s_{PL} > \widetilde{s}_{PL}$ with $s_{PL} < s_{NB}$; $\widehat{s}_{PL}$ is given by solving $\frac{p^e_{PL} - p^e_{NB}}{s_{PL} - s_{NB}} - \frac{p^e_{NB}}{s_{NB}} = 0$ for s_{PL} when $s_{PL} > s_{NB}$. In the latter case, the good with quality s_{NB} receives zero demand if $s_{PL} < \widehat{s}_{PL}$ for $s_{PL} > s_{NB}$. At the end, s_{NB} good receives zero demand if $s_{PL} \in (\widetilde{s}_{PL}, \widehat{s}_{PL})$ with $\widetilde{s}_{PL} < s_{NB} < \widehat{s}_{PL}$.

The function, we have to maximize is locally concave in s_{PL}.

- 2.1: $a \leq \frac{c_{NB}}{s_{NB}}$.

As previously (see 1.1), the demand for NB product is zero. The result is $s^*_{PL} = \widehat{s}^*_{PL}$ with $\widehat{s}^*_{PL} = \frac{2}{3}a$ and industry profits are $\pi_I(\widehat{s}^*_{PL}, \varnothing) = \frac{2}{27}a^3$.

- 2.2: $\frac{c_{NB}}{s_{NB}} < a \leq \frac{3c_{NB}}{s_{NB}}$.

Let start with $\frac{c_P}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

2.2.1: $\frac{c_{NB}}{s_{NB}} < a \leq \frac{3c_{NB}}{s_{NB}}$ *and* $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

Two sub-cases should be considered (depending on a):

2.2.1.1 the objective function admits a local solution in s_D, which is a global solution. Only one good is sold to consumers and, as PL product benefits from a competitive advantage, only this good is sold. In details, $\underline{s}^*_{PL} = \frac{3s_{NB} - \sqrt{9s^2_{NB} - 16c_{NB}}}{4}$ is larger than $\widetilde{s}_{PL}$, resulting in, when we study objective function, an increasing part when $s_{PL} < \widetilde{s}_{PL}$ and, then, a part which admits a local solution for $s_{PL} > \widetilde{s}_{PL}$.

2.2.1.2 the objective function may admit several local solutions in s_{PL}, that we will compare.

Let $\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right)$ denote this threshold in a; $\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right)$ is obtained by solving for a:

$$\left.\frac{p^e_{NB} - p^e_{PL}}{s_{NB} - s_{PL}}\right|_{s_{PL} = \underline{s}^*_{PL}} = a \text{ with } \underline{s}^*_{PL} = \frac{3s_{NB} - \sqrt{9s^2_{NB} - 16c_{NB}}}{4}.$$

We start with:

2.2.1.1: $\frac{c_{NB}}{s_{NB}} < a \leq \widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right)$ *and* $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

The demand for NB product is zero. The result is $\widehat{s}^*_{PL} = \widetilde{s}^*_{PL}$ with $\widehat{s}^*_{PL} = \frac{2}{3}a$ which leads to following industry profits $\pi_I\left(\widehat{s}^*_{PL}, \oslash\right) = \frac{2}{27}a^3$ (as in 2.1).

Then,

2.2.1.2: $\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \frac{3c_{NB}}{s_{NB}}$ *and* $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

Potentially, three local solutions can emerge:

$\underline{s}^*_{PL}$ with $\underline{s}^*_{PL} = \frac{3s_{NB}-\sqrt{9s^2_{NB}-16c_{NB}}}{4} < \widetilde{s}_{PL}$, resulting in:

$$\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right) = \frac{4c^2_{NB} + s_{NB}\left(\underline{s}^{*3}_{PL} + 4a^2\left(s_{NB} - \underline{s}^*_{PL}\right)\right) - 4s_{NB}\left(\underline{s}^{*2}_{PL} + 2a\left(s_{NB} - \underline{s}^*_{PL}\right)\right)}{16\left(s_{NB} - \underline{s}^*_{PL}\right)},$$

$\widehat{s}^*_{PL} = \frac{2}{3}a$ resulting in $\pi_I\left(\widehat{s}^*_{PL}, \oslash\right) = \frac{2}{27}a^3$, and

$\overline{s}^*_{PL} = \frac{a+2s_{NB}+\sqrt{4s^2_{NB}+a^2-2as_{NB}-6c_{NB}}}{3}$ resulting in:

$$\pi_I\left(\overline{s}^*_{PL}, s_{NB}\right) = \frac{\overline{s}^*_{PL}\left(4c^2_{NB} - 4c_{NB}\overline{s}^*_{PL}s_{NB} + s_{NB}\left(\overline{s}^{*3}_{PL} + 4a^2\left(\overline{s}^*_{PL} - s_{NB}\right) - 4a\overline{s}^*_{PL}\left(\overline{s}^*_{PL} - s_{NB}\right)\right)\right)}{16s_{NB}\left(\overline{s}^*_{PL} - s_{NB}\right)}.$$

We will proceed in two steps:

Let $\widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$ denote the value in a such that $\pi_I\left(\widehat{s}^*_{PL}, \oslash\right) = \pi_I\left(\overline{s}^*_{PL}, s_{NB}\right)$, we have : $\pi_I\left(\widehat{s}^*_{PL}, \oslash\right) \geq \pi_I\left(\overline{s}^*_{PL}, s_{NB}\right)$, if $\widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$ and $\pi_I\left(\widehat{s}^*_{PL}, \oslash\right) < \pi_I\left(\overline{s}^*_{PL}, s_{NB}\right)$, otherwise (i.e., for $\widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \frac{3c_{NB}}{s_{NB}}$). The analysis is made for $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

Thus, if $\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$, we have to compare $\pi_I\left(\widehat{s}^*_{PL}, \oslash\right)$ and $\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right)$. Let $\widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right)$ denote the value in a such that $\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right) = \pi_I\left(\widehat{s}^*_{PL}, \oslash\right)$. The result is: $\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right) \geq \pi_I\left(\widehat{s}^*_{PL}, \oslash\right)$ and $s^*_{PL} = \underline{s}^*_{PL}$, if $\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right)$; otherwise (i.e., $\widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \frac{3c_{NB}}{s_{NB}}$), we get $\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right) < \pi_I\left(\widehat{s}^*_{PL}, \oslash\right)$ and $s^*_{PL} = \widehat{s}^*_{PL}$ (for $a \leq \widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$).

Then, if $\widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \frac{3c_P}{s_{NB}}$, we have to compare $\pi_I\left(\underline{s}^*_{PL}, s_{NB}\right)$ and $\pi_I\left(\overline{s}^*_{PL}, s_{NB}\right)$.

Using the analysis above (see 1.3), we have

$$\begin{aligned} & \pi_I\left(\underline{s}_{PL}^*, s_{NB}\right) \geq \pi_I\left(\overline{s}_{PL}^*, s_{NB}\right) \text{ if } a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right) \\ \text{and} \quad & \pi_I\left(\underline{s}_{PL}^*, s_{NB}\right) < \pi_I\left(\overline{s}_{PL}^*, s_{NB}\right) \text{ if } a > \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right). \end{aligned}$$

Previous analysis results in $s_{PL}^* = \underline{s}_{PL}^*$ if $\frac{3c_{NB}}{s_{NB}} < a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$ and $s_{PL}^* = \overline{s}_{PL}^*$ if $a > \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$, when $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$ (for $a > \widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$).

2.2.2: $\frac{c_{NB}}{s_{NB}} < a \leq \frac{3c_{NB}}{s_{NB}}$ and $\frac{c_{NB}}{s_{NB}} > \frac{9}{16}s_{NB}$.

We have to compare two local solutions, $\widehat{s}_{PL}^* = \frac{2}{3}a$ resulting in $\pi_I\left(\widehat{s}_{PL}^*, \emptyset\right) = \frac{2}{27}a^3$ and $\overline{s}_{PL}^* = \frac{a+2s_{NB}+\sqrt{4s_{NB}^2+a^2-2as_{NB}-6c_{NB}}}{3}$ resulting in:

$$\pi_I\left(\overline{s}_{PL}^*, s_{NB}\right) = \frac{\overline{s}_{PL}^*\left(4c_{NB}^2 - 4c_{NB}\overline{s}_{PL}^*s_{NB} + s_{NB}\left(\overline{s}_{PL}^{*3} + 4a^2\left(\overline{s}_{PL}^* - s_{NB}\right) - 4a\overline{s}_{PL}^*\left(\overline{s}_{PL}^* - s_{NB}\right)\right)\right)}{16s_{NB}\left(\overline{s}_{PL}^* - s_{NB}\right)}.$$

Using the analysis above (see 2.2.1.2), the result is (for $\frac{c_{NB}}{s_{NB}} > \frac{9}{16}s_{NB}$): $\pi_I\left(\widehat{s}_{PL}^*, \emptyset\right) \geq \pi_I\left(\overline{s}_{PL}^*, s_{NB}\right)$ and $s_{PL}^* = \widehat{s}_{PL}^*$ if $\frac{c_{NB}}{s_{NB}} < a \leq \widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$; otherwise (i.e., $\widetilde{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \frac{3c_{NB}}{s_{NB}}$), we obtain $\pi_I\left(\widehat{s}_{PL}^*, \emptyset\right) < \pi_I\left(\overline{s}_{PL}^*, s_{NB}\right)$ and $s_{PL}^* = \overline{s}_{PL}^*$.

- 2.3: $a > \frac{3c_{NB}}{s_{NB}}$.

Let start with $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

2.3.1: $a > \frac{3c_{NB}}{s_{NB}}$ and $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

Two local solutions $\underline{s}_{PL}^*$ and $\overline{s}_{PL}^*$ have to be compared (with $\underline{s}_{PL}^* = \frac{3s_{NB}-\sqrt{9s_{NB}^2-16c_{NB}}}{4}$ and $\overline{s}_{PL}^* = \frac{a+2s_{NB}+\sqrt{4s_{NB}^2+a^2-2as_{NB}-6c_{NB}}}{3}$). Using the analysis above (see 1.3), we have:

$$\begin{aligned} & \pi_I\left(\underline{s}_{PL}^*, s_{NB}\right) \geq \pi_I\left(\overline{s}_{PL}^*, s_{NB}\right) \text{ if } a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right), \\ \text{and} \quad & \pi_I\left(\underline{s}_{PL}^*, s_{NB}\right) < \pi_I\left(\overline{s}_{PL}^*, s_{NB}\right) \text{ if } a > \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right). \end{aligned}$$

We thus obtain: $s_{PL}^* = \underline{s}_{PL}^*$ if $\frac{3c_{NB}}{s_{NB}} < a \leq \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$ and $s_{PL}^* = \overline{s}_{PL}^*$ if $a > \widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$, with $\frac{c_{NB}}{s_{NB}} \leq \frac{9}{16}s_{NB}$.

2.3.2: $a > \frac{3c_{NB}}{s_{NB}}$ and $\frac{c_{NB}}{s_{NB}} > \frac{9}{16}s_{NB}$.

We have a local solution $\overline{s}_{PL}^{*}$ which is a global solution. We thus obtain $s_{PL}^{*} = \overline{s}_{PL}^{*}$ which results in:

$$\pi_I\left(\overline{s}_{PL}^{*}, s_{NB}\right) = \frac{\overline{s}_{PL}^{*}\left(4c_{NB}^2 - 4c_{NB}\overline{s}_{PL}^{*}s_{NB} + s_{NB}\left(\overline{s}_{PL}^{*3} + 4a^2\left(\overline{s}_{PL}^{*} - s_{NB}\right) - 4a\overline{s}_{PL}^{*}\left(\overline{s}_{PL}^{*} - s_{NB}\right)\right)\right)}{16s_{NB}\left(\overline{s}_{PL}^{*} - s_{NB}\right)}.$$

To sum up, we will consider in the following analysis:

$$\widetilde{a}_3\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq Min\left\{\widetilde{a}_1\left(\frac{c_{NB}}{s_{NB}}\right), \widetilde{a}_4\left(\frac{c_{NB}}{s_{NB}}\right)\right\} \text{ with } \frac{c_{NB}}{s_{NB}} < \frac{9}{16}s_{NB}$$

($\frac{c_{NB}}{s_{NB}} < \frac{9}{16}s_{NB}$ is used here, when $\frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$, which corresponds to the case where the retailer benefits from a competitive advantage). In this situation, both products (with $s_{PL} < s_{NB}$) are sold when considering industry surplus and the PL quality is given by $s_{PL}^{*} = \underline{s}_{PL}^{*}$. Q.E.D.

B Proof of Proposition 2

The quality chosen by the retailer is given by the following F.O.C:

$$\left[p_{PL}^{e} - C_{PL}\left(s_{PL}\right)\right]\frac{\partial D_{PL}\left(., s_{PL}\right)}{\partial s_{PL}} = \frac{\partial C_{PL}\left(s_{PL}\right)}{\partial s_{PL}}D_{PL}\left(p_{PL}^{e}, +\infty, s_{PL}\right)$$

with $D_{PL}\left(p_{PL}^{e}, +\infty, s_{PL}\right) = a - \frac{p_{PL}^{e}}{s_{PL}}$, which results in $s_{PL}^{**} = \frac{2}{3}a$ ($= \widehat{s}_{PL}^{*}$, see Proof of Proposition 1).

We distinguish in the analysis the case where the retailer faces a comparative disadvantage and the case where it benefits from a comparative advantage.

Case 1: $C_{PL}\left(s_{NB}\right) \geq c_{NB}$: $\frac{c_{NB}}{s_{NB}} \leq \frac{s_{NB}}{2}$.

We have the following threshold values in s_{PL}:

$$\widehat{s}_{PL} < s_{NB} < \widetilde{s}_{PL}$$

and the analysis results from the comparison between s_{PL}^{**} and these threshold values.

- If $0 < s_{PL}^{**} \leq \widehat{s}_{PL}$, both qualities, s_{PL}^{**} and s_{NB} are sold at the equilibrium and $s_{PL}^{*} < s_{PL}^{**} < s_{NB}$;

- If $\widehat{s}_{PL} < s_{PL}^{**} \leq \widetilde{s}_{PL}$, only s_{NB} is sold;
- If $s_{PL}^{**} > \widetilde{s}_{PL}$, both qualities, s_{PL}^{**} and s_{NB} are sold at the equilibrium, but $s_{PL}^{**} > s_{NB}$.

Let $\overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$ and $\overline{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$ denote the following threshold values in a: $\overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$ is obtained by solving $s_{PL}^{**} = \widehat{s}_{PL}$, which results in $\overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) = 3\frac{c_{NB}}{s_{NB}}$ while $\overline{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$ is obtained from $s_{PL}^{**} = \widetilde{s}_{PL}$ leading to $\overline{a}_1\left(\frac{c_{NB}}{s_{NB}}\right) = \frac{3\left(3s_{NB}+\sqrt{9s_{NB}^2-16c_{NB}}\right)}{8}$.

We have,

- If $a \leq \overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$, both qualities, s_{PL}^{**} and s_{NB} are sold at the equilibrium with $s_{PL}^{*} < s_{PL}^{**} < s_{NB}$;
- If $\overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right) < a \leq \overline{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$, only s_{NB} is sold;
- If $a > \overline{a}_1\left(\frac{c_{NB}}{s_{NB}}\right)$, both qualities, s_{PL}^{**} and s_{NB} are sold at the equilibrium with $s_{PL}^{**} > s_{NB}$.

We now turn to the case where the retailer benefits from a comparative advantage.

Case 2: $C_{PL}(s_{NB}) < c_{NB}$: $\frac{c_{NB}}{s_{NB}} > \frac{s_{NB}}{2}$.

We have the following threshold values in s_{PL}:

$$\widetilde{s}_{PL} < s_{NB} < \widehat{s}_{PL}.$$

The comparison between s_{PL}^{**} and these threshold values leads to:

- If $a \leq \overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$, only s_{PL}^{**} is sold (because of the comparative advantage of the retailer);
- If $a > \overline{a}_2\left(\frac{c_{NB}}{s_{NB}}\right)$, both qualities, s_{PL}^{**} and s_{NB} are sold at the equilibrium with $s_{PL}^{**} > s_{NB}$. Q.E.D.