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Optimal production channel for private labels: Too much or too little innovation?*

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Abstract

We analyze the impact of the private label production channel on innovation. A retailer may either choose to integrate backward with a small firm (insourcing) or rely on a national brand manufacturer (outsourcing) to produce its private label. The trade-off between insourcing and outsourcing strategies is a choice between too much or too little innovation (*i.e.,* quality investment) on the private label. When insourcing, an outside-option effect leads the retailer to over-invest to increase its buyer power. When outsourcing, a hold-up effect leads to under-investment. In addition, selecting the national brand manufacturer may create economies of scale that spur innovation.

JEL-Classification: L14, L15, L42
Keywords: Private label, vertical relations, buyer power, innovation.

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1 Introduction

The sale of private label goods has reached approximately 25% of global supermarket sales, compared with 15% in 2003. In some European countries these products exceed half of all sales (53% in Switzerland and 51% in Spain).[1] In the US private labels accounted for approximately 19% of market shares in 2012.[2]

Although private labels were initially positioned as low-quality "me-too" products, their quality has significantly improved and private labels are increasingly innovative.[3] "Economy private labels" and "premium private labels" often co-exist on retailers' shelves.

The two main channels for the production of private labels are small firms and, increasingly, national brand producers themselves. In the U.S., more than 50% of national brand producers make private label goods in addition to their national brand (Quelch and Harding, 1996; ter Braak *et al.*, 2013). Some national brand manufacturers are leaders in private label goods production, such as Heinz for baby food.

This article analyzes the main drivers of a retailer's choice of its premium private label production channel and the consequences of this choice on product innovation and welfare.

In the model developed here, a monopolist retailer can sell a national brand and a premium private label. Some consumers have an intrinsic preference for the national brand. To develop a premium private label, the retailer can choose either an outsourcing strategy or an insourcing strategy. We define *outsourcing* as contracting with a national brand producer that enters into dual branding. In that case, the retailer relies entirely on the producer's capacity to innovate. In contrast, we define *insourcing* as buying the private label from a (small) dedicated manufacturer that sells at cost to the retailer. In this case, the innovation process for the private label relies entirely on the retailer. Insourcing boils down to backward integration. In both cases, innovation is undertaken before firms bargain over sales revenue.

The trade-off between the two channels is primarily a choice between too much and too little innovation on the private label. Outsourcing may create economies of scale that spur innovation. Despite this straightforward argument in favor of outsourcing, this strategy may lead to too little innovation. Indeed, when outsourcing, a standard hold-up effect implies that the brand manufacturer under-invests in the private label quality. In contrast, when insourcing, the retailer over-invests to increase its outside option, and therefore its buyer power toward the national brand manufacturer.

In equilibrium, insourcing paradoxically emerges when the retailer's bargaining power is sufficiently high. This is because the inefficiency due to the outside-option effect is all the stronger when the retailer's bargaining power is initially weak. This choice may be detrimental to welfare because consumers may be hurt by too little innovation on the private label.

Few papers have analyzed the retailer's choice of production channel for private labels.[4]

[1] http://www.plmainternational.com/industry-news/private-label-today

[2] http://plma.com/storeBrands/sbt13.html

[3] For instance, although brands held a 55% share of total new product development in 2010 in the UK, the balance switched in 2011 in favor of private labels, which accounted for 54% of new product development. http://www.storebrandsdecisions.com/news/2012/05/29/mintel-private-label-product-development-outpaces-cpg-in-the-uk.

[4] The industrial organization and marketing literature has mostly analyzed the retailer's rationale for

To our knowledge, only Bergès-Sennou (2006), Tarziján (2007) and Bergès and Bouamra-Mechemache (2011) have directly analyzed this issue. Bergès-Sennou (2006) focuses on store and brand loyalty, explicitly considering retail competition. Tarziján (2007) analyzes the incentive for a brand producer to enter into dual-branding by balancing cost synergies with cannibalization effects. In contrast with these two papers that rule out the issue of quality investments, the present paper focuses on innovation issues.

Bergès and Bouamra-Mechemache (2011) consider quality investment on the private label and assume that quality is contractible. We depart from their analysis in two main directions: First, we consider non-contractible investments and inherent hold-up issues. The quality of the goods sold includes various dimensions such as a better recipe, texture, preservation, packaging or lower environmental footprint. These innovations cannot be easily described *ex-ante*, and the efforts spent on R&D cannot be contracted upon because of costly verifiability. Second, we take into account innovation on both the private label and the national brand.

Our paper is also related to the literature that addresses the effect of buyer power on investment decisions within a vertical chain. Battigalli *et al.* (2007) show that buyer power may weaken the producer's incentive to engage in quality improvement due to the hold-up problem. Focusing on technology adoption, Inderst and Wey (2003, 2007) show that buyer power may increase suppliers' incentives to innovate to make up for their loss of bargaining power. We obtain a similar result through a different mechanism: an increase in the buyer power induces a switch from outsourcing to insourcing which spurs the private label quality investment. This switch benefits consumers.

This article is organized as follows. Section 2 derives the model assumptions. Section 3 analyzes the two major private label production channels: outsourcing *vs* insourcing. In Section 4, we determine the optimal choice of private label production channel for the retailer according to its bargaining power and the initial intrinsic preference for the national brand. In Section 5 we derive some implications regarding consumer surplus and welfare. Section 6 concludes.

2 The model

We consider a framework in which a monopolist retailer, R, may sell two different goods, a national brand B supplied by a brand producer P and a private label L. The retailer may either outsource or insource the production of L. These strategies are denoted by the superscripts O and I, respectively. When outsourcing, the retailer signs a contract with the producer for the exclusive production of L. When insourcing, the retailer integrates backward.

Firms may innovate by investing in the quality of both B and L. The investments over B and L are denoted k_B and k_L, respectively. These qualities affect the gross surplus of consumers. The quality of the national brand is chosen by P, and the quality of the private label is chosen either by P (outsourcing) or R (insourcing).

On the demand side, there are two types of consumers "brand lovers" and "standard consumers". Absent any difference in quality and price, brand lovers have an intrinsic preference

launching private labels (see Bergès *et al.*, 2004, for a survey).

for good B represented by parameter δ, whereas standard consumers consider B and L to be homogeneous goods.

Each consumer only buys one type of good. The consumer chooses the good with the highest perceived quality net of the price and has a linear demand for this good. That is, a standard consumer buys a quantity $v + k_B - p_B$ of good B if $k_B - p_B$ is higher than $k_L - p_L$, and a quantity $v+k_L-p_L$ of good L otherwise. A brand lover buys a quantity $v+\delta+k_B-p_B$ of good B if $\delta+k_B-p_B$ is higher than k_L-p_L, and a quantity $v+k_L-p_L$ of good L otherwise. We assume that $\delta < v$.[5]

The total mass of consumers is normalized to 1. There is a share λ of brand lovers and a share $1-\lambda$ of standard consumers. The demand functions, D_B and D_L for the national brand and the private label are given in the following table for $p_L < v + k_L$:

	D_B	D_L
If $p_B \in [0, k_B - k_L + p_L]$	$v + \lambda\delta + k_B - p_B$	0
If $p_B \in [k_B - k_L + p_L, p_L + \delta + k_B - k_L)$	$\lambda(v + k_B + \delta - p_B)$	$(1-\lambda)(v + k_L - p_L)$
If $p_B \geq p_L + \delta + k_B - k_L$	0	$v + k_L - p_L$

If, however, $p_L \geq v + k_L$, then $D_L = 0$. Again, we have three cases:

$$D_B = \begin{cases} v + \lambda\delta + k_B - p_B & \text{if} \quad p_B \in [0, v + k_B], \\ \lambda(v + k_B + \delta - p_B) & \text{if} \quad p_B \in [v + k_B, v + \delta + k_B], \\ 0 & \text{if} \quad p_B > v + \delta + k_B, \end{cases}$$

The corresponding surplus of a standard consumer (resp. a brand lover) is denoted S_0 (resp. S_δ). The expression of the surplus for a consumer that purchases a quantity q_i of good i ($i = B, L$) is:

$$S_x = \left(v - \frac{1}{2}(q_B + q_L)\right)(q_B + q_L) + (x + k_B)q_B + k_L q_L - p_B q_B - p_L q_L,$$

with $x = \delta$ for a brand lover and $x = 0$ for a standard consumer. The total consumer surplus is $\lambda S_\delta + (1-\lambda)S_0$.

The cost of quality investments and the choice of these investments depend on the private label production channel. When the retailer R chooses outsourcing (*i.e.,* contracts with the national brand producer that enters into dual branding), we assume that the national brand producer P chooses both qualities k_B and k_L; in that case, the associated cost, which is borne entirely by P, is $C(Max[k_B, k_L])$. If P has spent $C(k)$, any downgraded level of quality can be offered without additional cost. Moreover, for a given level of quality investment there is no additional cost to offer two goods instead of one. The firm can differentiate the private label from the national brand at no cost. The difference is only a matter of packaging and the associated packaging cost is neglected.[6]

[5]This specification initially introduced by Soberman and Parker (2004) is sustained by a survey conducted in the U.S. in 2010, that showed that 19% of consumers believe that it is worth paying more for name-brand products. See `http://www.mintel.com/press-centre/food-and-drink/private-label-gets-a-quality-reputation-causing-consumers-to-change-their-buying-habits`.

[6]Our results are qualitatively unchanged without scale economies on quality investment. This extension is available upon request.

When insourcing (*i.e.,* integrating backward with a dedicated manufacturer), R invests in the quality k_L of its private label and bears the associated cost $C(k_L)$. P can make a quality investment k_B on the national brand at cost $C(k_B)$.

Investment costs are quadratic and identical for all firms and products: $C(k_i) = \frac{k_i^2}{2}$ where $i = B, L$.[7] The marginal cost of production is assumed to be constant and is normalized to 0.

Once quality investments have been made, R and P bargain over the revenue from sales according to a standard Nash bargaining approach.[8] The exogenous bargaining power of R relative to P is a parameter $\alpha \in [0, 1]$. In equilibrium, R (respectively P) earns its outside-option profit plus a share α (resp. $1 - \alpha$) of its incremental gain from trade with P.

The timing of the game is as follows.

Stage 1: Choice of the private label production channel: insourcing *vs* outsourcing.

R may sign contract with P for the exclusive production of the private label (outsourcing) or choose to integrate backward (insourcing). The contract takes the form of a fixed fee.

Stage 2: Innovation choice.

- Insourcing: Simultaneously, P and R choose k_B at cost $C(k_B)$ and k_L at cost $C(k_L)$, respectively.
- Outsourcing: P chooses k_L and k_B at cost $C(Max[k_L, k_B])$.

Firms can no longer invest in quality after the end of this innovation stage.

Stage 3: Bargaining stage.

- Insourcing: R and P bargain over a fixed transfer for the delivery of B. In case of a breakdown in the negotiation, P has no outside option whereas R can still sell its private label of quality k_L.
- Outsourcing: R and P bargain over a fixed transfer for the delivery of B and L. In case of a breakdown in the negotiation, neither P nor R has any outside option.

Stage 4: R sells either one or both goods to consumers and sets the retail prices p_L and p_B.

Some comments regarding the assumptions of the game are in order.

The production channel is chosen prior to quality investments. Premium private labels require quality investments developed through a manufacturer–retailer partnership that lasts more than a year (*i.e.,* more than the usual term of producer-retailer negotiations (ter Braak

[7]Note that in this model we focus on deterministic quality investments. Indeed, innovation in the consumer-packaged-good industries primarily consists of ensuring constant quality improvements, and radical innovations are rare events (Pauwels and Srinivasan, 2004; Steiner, 2004). Radical innovations represent approximately 6% of total innovation output (Martos-Partal, 2012).

[8]Note that we consider fixed transfers without loss of generality. As noted by O'Brien and Shaffer (1997), with a standard two-part tariff, the wholesale price would be set to the marginal cost (here 0), and the fixed transfer would be unchanged.

et al., 2013)). This contrasts with economy private labels, which are put out for bid to manufacturers every year. Quality investments take place before short-term negotiation and cannot be contracted upon in the long-term. In the long term, contracts are incomplete because a product innovation cannot be precisely described *ex-ante*, and R&D spending cannot be verified by a third party.

In the first stage, the retailer and the producer may sign a contract for the exclusive production of the private label by the producer. Transfers can go either way, and therefore, such a contract is signed as long as the industry profit increases with outsourcing. In particular, up-front lump-sum transfers from the producer to the retailer such as slotting fees or payment for commercial services, are known to be widely used although very opaque (see, e.g., FTC, 2003).[9] Although there is no evidence of explicit long-term exclusive contracts between retailers and producers for the production of private labels, we assume here that the producer signs such an exclusive contract to protect itself against the retailer's opportunism. The retailer could simultaneously integrate backward to increase its bargaining power in stage 3 and extract more rent from the producer's investment on the private label.

We consider subgame perfect equilibrium and proceed by backward induction. Because the last stage is not affected by the production channel choice, we solve it here. Qualities k_B and k_L are fixed, and R chooses prices that maximize the industry profit. Three cases may arise: first, R may sell only L to all consumers; second, R may sell the two goods B and L; finally, R may sell only B to all consumers.

- When only the private label is sold, the industry profit is $(v + k_L - p_L)p_L$, and R sets the optimal price $p_L = \frac{v+k_L}{2}$.
- When both the private label and the national brand are sold, the industry profit is $\lambda(v+\delta+k_B-p_B)p_B+(1-\lambda)(v+k_L-p_L)p_L$, and R sets the optimal prices $p_L = \frac{v+k_L}{2}$ and $p_B = \frac{v+\delta+k_B}{2}$.
- When only the national brand is sold, the industry profit is $(v + \lambda\delta + k_B - p_B)p_B$, and R sets the optimal price $p_B = \frac{v+\lambda\delta+k_B}{2}$.

The option that is the most profitable depends on the qualities of the two products. The industry revenue, denoted $\pi(k_L, k_B)$, is as follows:

$$\pi(k_L,k_B) = \begin{cases} \frac{1}{4}(v+k_L)^2 & \text{for} \quad k_B \in [0, k_L-\delta], \\ \frac{\lambda}{4}(v+\delta+k_B)^2 + \frac{1-\lambda}{4}(v+k_L)^2 & \text{for} \quad k_B \in (k_L-\delta, \sqrt{(k_L+v)^2+\lambda\delta^2}-v], \\ \frac{1}{4}(v+\lambda\delta+k_B)^2 & \text{for} \quad k_B > \sqrt{(k_L+v)^2+\lambda\delta^2}-v. \end{cases} \tag{1}$$

Given our assumption $\delta < v$, when R sells only the national brand, it strictly prefers to sell B at a lower price to all consumers rather than sell it at a higher price to brand lovers only.

[9]Slotting fees are up-front lump-sum transfers from the producer to the retailer that are not contingent on qualities or even on the actual selling of the product. Whether the product is actually sold depends on the success of subsequent short-term negotiations. A recent body of literature models these features of slotting fees (see, e.g., Marx and Shaffer, 2010), with a structure similar to our two-stage contracting process. Chu (1992) and Yehezkel (2014) show that this sequential contracting framework can be explained by the asymmetric information associated with a new product demand.

3 Private label production channel and innovation

In this section, we solve Stages 2 and 3 of the game to highlight how the choice of the private label production channel affects innovation with respect to both the national brand and the private label.

3.1 Industry optimum

Before we determine the equilibrium quality choices for each production channel, it is useful to focus on a benchmark, to which we will henceforth refer as the industry optimum. If it were possible for the two firms to write complete contracts, they would be able to contract on qualities to maximize their joint profits. The choice of the production channel beforehand influences the maximization problem because cost structures differ depending on whether the retailer chooses outsourcing or insourcing. More precisely, joint profits net of investment costs in these two cases are respectively:

$$\Pi^O(k_L, k_B) = \pi(k_L, k_B) - C(Max[k_B, k_L]), \tag{2}$$
$$\Pi^I(k_L, k_B) = \pi(k_L, k_B) - C(k_B) - C(k_L). \tag{3}$$

Optimal strategies are given in the following lemma.

Lemma 1. *With outsourcing, the industry profit is maximum for $k_B = k_L = k^* = v + \lambda\delta$. Then, the national brand is sold to brand lovers and the private label is sold to standard consumers.*

With insourcing, the industry profit is maximum for $k_B = k^*$ and $k_L = 0$. Then the national brand is sold to both types of consumers.

Proof. See Appendix A.1 □

Interestingly, the same quality is implemented in both cases for the goods that are actually sold on the final market. The main difference is due to cost duplication inherent to the insourcing case. When insourcing, it is never profitable to sell the private label because it would require an additional investment cost that always exceeds the discrimination benefit.

It is clear that without any incompleteness of contracts, the best option would always be outsourcing that enables discrimination without any additional cost. Denoting Π^{i*} the optimal joint profit in channel i ($i \in \{O, I\}$), we therefore have $\Pi^{O*} > \Pi^{I*}$. We will henceforth refer to k^* as the "optimal" quality, in the sense that it is optimal for the industry.

3.2 Outsourcing

In this subsection, R entrusts P with the production of the private label. P thus chooses both qualities k_L and k_B and pays the associated investment cost $C(\max[k_L, k_B])$. In Stage 4, the revenue of the industry is given by $\pi(k_L, k_B)$ defined by eq. (1).

At the bargaining stage, the sharing of $\pi(k_L, k_B)$ between the producer and the retailer depends on the relative bargaining power of each firm, given by α and their outside options.

Both outside options are 0. Nash bargaining leads to the following profits:

$$\Pi_P^O(k_L, k_B) = (1-\alpha)\pi(k_L, k_B) - C(Max[k_L, k_B]) \tag{4}$$
$$\Pi_R^O(k_L, k_B) = \alpha\pi(k_L, k_B) \tag{5}$$

Lemma 2. *With outsourcing, the national brand producer always makes the same quality investment in both products, and there exists a unique equilibrium in which the retailer sells both the national brand and the private label to consumers.*

Proof. Please refer to Appendix A.2. □

Regardless of the investment made by the producer it is always optimal for P, as well as for the industry, to sell both goods and make similar quality investments. Once P has made an investment, it has no incentive to downgrade the quality of the private label or the national brand. Indeed, once the investment cost is paid, the revenues from the sale of the private label and the brand both strictly increase with respect to quality. Furthermore, for similar qualities, it is always optimal for the industry that the two goods are sold. Indeed, it is always possible to discriminate among consumers simply by differentiating packages: with identical qualities brand lovers do not buy the private label.

In contrast with the optimal quality k^*, however, the equilibrium quality investment set by P is determined by its marginal benefit $(1-\alpha)\left[\partial\pi/\partial k_B + \partial\pi/\partial k_L\right]$. P thus under-invests compared with k^*. The equilibrium qualities of the outsourcing subgame are denoted k_B^O, k_L^O.

Proposition 1. *With outsourcing, the equilibrium quality investment is:*

$$k_B^O = k_L^O = k^O = (v + \lambda\delta)\frac{1-\alpha}{1+\alpha}.$$

Due to a "hold-up effect", this quality is always lower than the optimal quality k^* and is decreasing with respect to the bargaining power of the retailer α.

Proof. See Appendix A.3. □

Replacing k^O in eq. (2), the corresponding total industry profit obtained with outsourcing is denoted Π^O, and the difference $\Pi^O - \Pi^{O*} \leq 0$ is entirely due to the hold-up inefficiency. The difference is maximum when $\alpha = 1$ and is brought to 0 when $\alpha = 0$ because all the power is in the hands of P, and there is no more hold-up.

3.3 Insourcing

In this subsection, R integrates backward the production of its private label. P (resp. R) thus chooses quality k_B (resp. k_L) and pays the associated investment cost $C(k_B)$ (resp. $C(k_L)$). In the bargaining stage, the total revenue from sales $\pi(k_L, k_B)$ is shared among the two firms. The outside-option revenue of the retailer amounts to the revenue it would earn by selling only its private label to all consumers, $\overline{\pi}(k_L) = \frac{1}{4}(v + k_L)^2$. By contrast, P has no outside-option revenue. Accordingly, profits are as follows:

$$\Pi_P^I(k_L, k_B) = (1-\alpha)\left[\pi(k_L, k_B) - \overline{\pi}(k_L)\right] - C(k_B), \tag{6}$$
$$\Pi_R^I(k_L, k_B) = \overline{\pi}(k_L) + \alpha\left[\pi(k_L, k_B) - \overline{\pi}(k_L)\right] - C(k_L). \tag{7}$$

We determine the Nash equilibrium of the subgame with insourcing. An equilibrium is completely characterized by a pair of qualities chosen by P and R who maximize their profits (6) and (7). There are three equilibrium candidates where either both goods are sold, or only the national brand or the private label is sold. These three types of equilibria are henceforth denoted (BL), (B) and (L). The domain of existence of each type of equilibrium is determined by checking the incentives of P and R to deviate. Depending on the values of the parameters α, δ, and λ, all three situations may arise along an equilibrium path and one, two or three equilibria may coexist. Note that whenever there is a multiplicity of equilibria, there is always one equilibrium that Pareto dominates the others. We assume that in the event of coexistence, the dominant equilibrium is played.

Lemma 3. *With insourcing, there exist three thresholds δ_1, δ_2 and δ_3 such that:*

- *If the initial advantage of the national brand δ belongs to the interval $[\delta_2, \delta_3]$, there exists a dominant equilibrium, denoted (B), such that only the national brand is sold.*
- *Otherwise, if $\delta > \delta_1$, the dominant equilibrium is (BL) and if $\delta \leq \delta_1$, the unique equilibrium is (L).*

Proof. See Appendix A.4 for a proof and the expressions of thresholds δ_2 and δ_3. □

In Lemma 3, we use the parameter δ to characterize the boundaries between the three types of equilibria because it is more intuitive than the comparative statics in α. Figure 1 depicts the equilibrium boundaries depending on the values of λ and α:

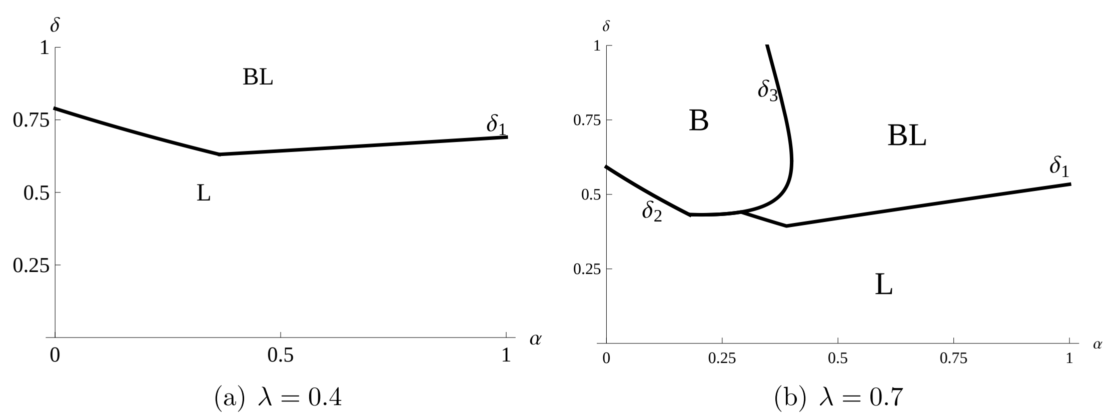


Figure 1: Equilibria (B), (BL) and (L), according to δ and α, for a low and a large λ.

We first discuss the left-hand figure, in which λ is low.

First, when buyer power α is low, the quality investment of R is high. When the initial advantage of the national brand δ is sufficiently low ($\delta < \delta_1$), it is too costly for the producer to maintain the coexistence. P thus prefers to make no investment, deviating from a coexistence equilibrium candidate toward a situation in which only L is sold. In contrast, when δ is above δ_1, it becomes profitable for the producer to maintain the coexistence because of its large initial advantage δ.

Second, for high values of buyer power, the quality investment of P is low. When the initial advantage of the national brand δ is sufficiently low ($\delta < \delta_1$), the retailer has no incentive to discriminate by selling the national brand and instead prefers to sell a better-quality private label to all consumers. When δ is high enough, however, the retailer finds it more profitable to sell both B and L to discriminate consumers rather than to sell only L.

We now discuss the right-hand figure, in which equilibrium (B) exists. Note that (B) arises when λ is high because more consumers are willing to pay for the national brand. In this case, (B) is favored by a high value of δ and a low buyer power α. As mentioned above, the lower the buyer power, the higher the retailer's quality investment. This may still discourage coexistence, but in this case, in which δ is sufficiently high, it is more profitable to give up on the private label rather than the national brand.

Proposition 2. *In the three possible types of equilibrium of the insourcing subgame, the equilibrium qualities are, respectively,*

$$(k_L^I, k_B^I) = \begin{cases} (k_L^{BL}, k_B^{BL}) & = & (v\frac{1-\alpha\lambda}{1+\alpha\lambda}, \frac{\lambda(1-\alpha)(v+\delta)}{2-\lambda(1-\alpha)}) & \textit{if both B and L are sold,} \\ (k_L^{L}, k_B^{L}) & = & (v, 0) & \textit{if only L is sold,} \\ (k_L^{B}, k_B^{B}) & = & (v\frac{1-\alpha}{1+\alpha}, \frac{(1-\alpha)(v+\lambda\delta)}{1+\alpha}) & \textit{if only B is sold.} \end{cases}$$

In contrast with the optimum, in which only the producer innovates and sets quality k^*, the retailer always innovates, and the private label is sold too often.

In equilibrium (B) or (BL): Due to the hold-up effect the national brand quality is always lower than k^* and decreasing with respect to α. Due to an "outside-option effect", the private label quality is higher than the optimal quality, 0, and is decreasing with respect to α.

In equilibrium (L): The outside-option effect triggers an extreme form of hold-up: the brand is not sold.

Proof. The expressions of the equilibrium qualities are obtained from the first-order conditions for each type of equilibrium (see Appendix A.4). The comparison with the optimum is straightforward from Lemma 1. □

In both equilibria (B) and (BL), the quality of both the national brand and, surprisingly, the private label strictly decrease with respect to α. The quality of the national brand is determined by P's own marginal benefit instead of the marginal benefit of the industry. A hold-up effect similar to the effect discussed in the outsourcing subgame arises.

In these equilibria, the quality of the private label is determined by R's own marginal benefit $\partial\pi/\partial k_L + (1-\alpha)\,[\partial\overline{\pi}/\partial k_L - \partial\pi/\partial k_L]$, instead of the marginal benefit of the industry. R has an incentive to over-invest to increase its outside-option revenue $\overline{\pi}(k_L)$. We call this effect an "outside-option effect". It leads to over-investment because the quality of the private label has a stronger effect on the retailer's outside option than on the total industry profit. The quality k_L decreases with respect to α because when α is low, the retailer's profit is mainly determined by its outside option. Due to this effect, the equilibrium private label quality in cases (B) and (BL) is higher than the optimal quality, 0.

Equilibrium (L) may arise because an extreme form of hold-up effect may be triggered by the outside-option effect. Then the outside option of the retailer does not affect the marginal benefit of the producer's investment, and thus the value of k_B, but it influences the producer's decision to invest at all. When the national brand advantage δ is low, the retailer invests so heavily in the quality of its private label that it completely discourages the producer from investing in its national brand quality.

4 Choice of the private label production channel

In equilibrium, outsourcing is chosen if and only if it maximizes the industry profit, *i.e.*,

$$\Delta_{O,I} \stackrel{def}{=} \Pi^O - \Pi^I > 0.$$

With complete contracts, the best option would always be outsourcing: $\Pi^{O*} > \Pi^{I*}$. Contract incompleteness induces inefficiencies in both channels that may explain why the retailer may wish to integrate backward. One way to disentangle the various effects at stake is to write the comparison:

$$\Delta_{O,I} = \underbrace{\left[\Pi^{O*} - \Pi^{I*}\right]}_{\text{cost duplication or discrimination}} + \underbrace{\left[\Pi^{O} - \Pi^{O*}\right]}_{\text{hold-up with outsourcing}} + \underbrace{\left[\Pi^{I*} - \Pi^{I}\right]}_{\substack{\text{hold-up and outside-option} \\ \text{effects with insourcing}}} . \quad (8)$$

The first term is strictly positive. It casts the positive effect related to the absence of cost duplication with outsourcing, and it represents the difference between the optimal industry profits with and without cost duplication. The gain can also be interpreted as a benefit from discrimination; with outsourcing, the same good can be sold at two different prices with two different packages to extract the brand lovers' surplus δ; with insourcing, a second good should be developed.

The second term is negative and corresponds to the loss resulting from the hold-up effect due to outsourcing. This term is equal to 0 for $\alpha = 0$ and increases with respect to the bargaining power of the retailer.

Finally, the third term is positive and encompasses the gain from insourcing when correcting both for the hold-up and the outside-option effects described in subsection 3.3. The monotonicity of this term with respect to α is *a priori* ambiguous because the hold-up effect is aggravated whereas the outside-option effect is reduced when α increases.

Proposition 3. *There exist two thresholds α^* and α^{**} in $(0, 1)$ such that:*

- *When both the national brand and the private label are sold with insourcing, outsourcing is chosen when the retailer's bargaining power α is lower than α^{**};*

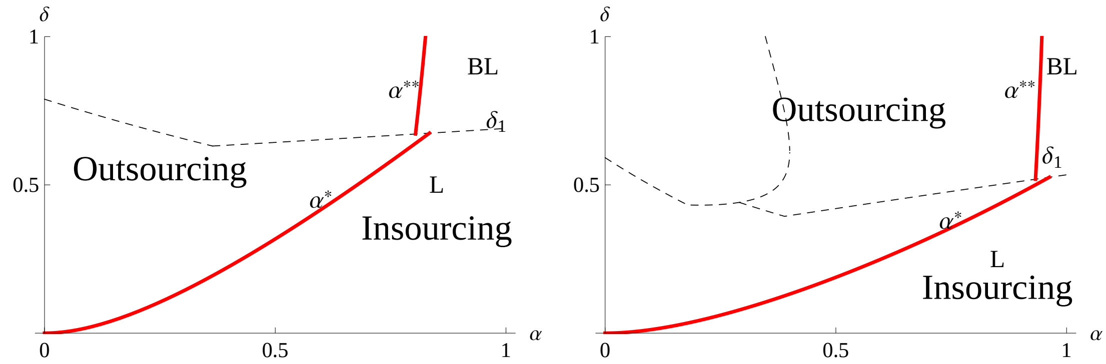
- *When only the private label is sold with insourcing, outsourcing is chosen when α is lower than α^*;*

- *When only the national brand is sold with insourcing, outsourcing is always chosen.*

Both thresholds are increasing with respect to δ.

Proof. See Appendix A.5 □

In figure 2, we draw the thresholds mentioned in Proposition 3 together with the boundary between equilibria (L) and (BL) highlighted in 3.3, for $\lambda = 0.4$ and $\lambda = 0.7$, and $v = 1$.[10]



(a) $\lambda = 0.4$ (b) $\lambda = 0.7$

Figure 2: Outsourcing *vs* insourcing as a function of α and δ.

The choice between outsourcing and insourcing is clear in the two extreme cases $\alpha = 0$ and $\alpha = 1$. When $\alpha = 0$, with the decomposition (8), the first term is strictly positive, the second term is zero as there is no hold-up inefficiency with outsourcing, and the third term is positive as there is an outside-option inefficiency with insourcing: outsourcing is always chosen. When $\alpha = 1$ it is more intuitive to directly compare the profits Π^I and Π^O. With outsourcing the hold-up effect prevents any investment in both goods. The profit of the producer is zero. With insourcing, the profit of the producer is also zero; the retailer could mimic the outsourcing outcome by not investing but always prefers to invest. Therefore, insourcing clearly raises industry profit and is chosen.

Between these two extreme cases, the appeal of outsourcing is decreasing with respect to the bargaining power of the retailer. Consider first the case in which only the national brand is sold with insourcing (equilibrium (B)) which occurs for low values of the parameter α. The quality of the national brand is similar with insourcing and outsourcing from Propositions 1 and 2. It is then straightforward that outsourcing is always profitable because it allows the retailer to discriminate and sell a private label with the same quality as the national brand to standard consumers. With insourcing there is a useless development of the private label quality that further reduces the industry profit.

Consider now the case in which both goods are sold with insourcing (equilibrium (BL)). It is shown in Appendix A.5 that the comparison of profits, $\Delta_{O,I}$, is decreasing with respect to α despite the non-monotonicity of the industry profit with insourcing. An increase of the retailer's bargaining power α reduces the inefficiency associated with the outside-option

[10]The explicit expressions of these thresholds are cumbersome, to say the least, but are available upon request.

effect in insourcing. It also aggravates the inefficiency associated with the hold-up effect both in insourcing and outsourcing. Because the inefficiency is larger with outsourcing (it involves a larger investment), the negative effect of an increase of α on the outsourcing profit dominates its effect on the insourcing profit, whether the latter is positive or negative. The difference in profits $\Delta_{O,I}$ is therefore decreasing with respect to α.

Finally, when only the private label is sold with insourcing (equilibrium (L)), the profit with insourcing does not depend on α, and the difference in profits $\Delta_{O,I}$ is unambiguously decreasing with respect to α. Outsourcing is the most profitable industry configuration when α is small. In that case, outsourcing allows the national brand to be maintained on the retailer's shelves.

The incentive to outsource is increasing with respect to the preference for the national brand, δ. δ has two effects on the difference between the two profits $\Delta_{O,I}$: a direct effect through the demand functions and an indirect effect through quality investment decisions. The direct effect is proportional to the demand for the national brand. Because the quality of the national brand is larger with outsourcing than with insourcing, so is demand for the national brand, and therefore, the direct effect is positive. The indirect effect operates via the increase of the national brand quality. With both production channels, an increase of δ induces an increase of the national brand quality that has a positive effect on the industry profit because of the hold-up effect. This benefit is higher with outsourcing than with insourcing because the hold-up effect is more severe in the former case (see eq. (12) in Appendix A.5).

It is interesting to note that the production channel influences the assortment of goods on the retailer's shelves.

Corollary 1. *Allowing the retailer to outsource has the following consequences:*

- *the private label is always on the retailer's shelves;*
- *the national brand is more often on the retailer's shelves.*

This corollary illustrates well the debate on whether national brand producers should begin producing private labels (see Quelch and Harding, 1996). On the one hand, there is a risk of cannibalization of the brand sales by the private label (when (B) is the insourcing equilibrium). On the other hand, there are situations in which outsourcing enables the producer to maintain its brand on the retailer's shelves. This finding is comforted by ter Braak *et al.* (2013)'s empirical analysis which shows that supplying a private label increases the likelihood of shelf presence for the national brand manufacturer's own products.

5 Surplus analysis

The choice of the private label production channel affects consumer surplus insofar as it affects quality investments.[11]

Proposition 4. *Outsourcing decreases consumer surplus if:*

[11] The surplus analysis is obtained by computing S_0 and S_δ at the equilibrium qualities and comparing the consumer surplus with insourcing and with outsourcing.

- *the insourcing equilibrium is (B),*

- *the insourcing equilibrium is (BL) and* $\alpha > \hat{\alpha}^{**}$ *in which* $0 < \hat{\alpha}^{**} < \alpha^{**}$*,*

- *the insourcing equilibrium is (L) and* $\alpha > \hat{\alpha}^{*}$ *in which* $0 < \hat{\alpha}^{*} < \alpha^{*}$*,*

Proof. See Appendix A.6 □

When α is close to 0 (and the private label is offered in the insourcing equilibrium), outsourcing always increases surplus because the hold-up effect is the lowest, so qualities are much improved compared with insourcing because of the economies of costs. When α is larger, the hold-up effect is important when the retailer insources or outsources. However, compared to insourcing, the quality investment on L is greatly reduced with outsourcing. As a result, outsourcing is harmful to consumers when the bargaining power of the retailer α is close to the boundaries α^* and α^{**}. When only B is sold with insourcing, outsourcing always reduces consumer surplus because it allows the retailer to discriminate among consumers instead of selling B at the same price to all consumers.

If insourcing is chosen in equilibrium, it is always beneficial both for industry profit and social welfare. In that case, the positive effect of avoiding both a duplication of investment costs and the outside-option effect is insufficient to compensate for the lower quality of L due to hold-up.

6 Conclusion

This article analyzes the choice by a retailer of the supply channel for its private label. The analysis emphasizes the role played by innovation in both the quality of the private label (the outsourced good) and the national brand (an imperfect substitute) on the comparison between supply channels. We show that a retailer may prefer to entrust a national brand producer with the manufacturing of a private label rather than produce the private label on its own.

Two main forces are at work. First, entrusting the national brand producer with the production of the private label may avoid the duplication of R&D costs, which tends to increase the qualities of the two goods. Second, this choice destroys the incentive of the retailer to over-invest in the private label quality to increase its outside option and gain buyer power toward the national brand manufacturer. When the buyer power of the retailer is not strong and the preference for the national brand is sufficient, these two positive effects prevail over the hold-up effect that pushes the producer to under-invest in quality, and outsourcing prevails over insourcing.

The choice of a production channel determines not only the qualities of the two goods but also which goods appear on the retailer's shelves. In some cases, entrusting the national brand producer with the production of the private label implies that two products are sold instead of one. In some circumstances, it ensures that the national brand is sold by preventing the retailer from over-investing; in others, it enables the retailer to sell the private label and discriminate among consumers.

Finally, we acknowledge that the effects described are short-term effects and some could be exacerbated or reversed in the long run. From the producer's point of view, controlling the quality gap between the national brand and the private label may increase consumers' preference for the national brand in the long run. In contrast, if it is publicly revealed to consumers that the national brand manufacturer produces the private label, this may negatively affect the consumers' preference for the national brand. From the retailer's point of view, when entrusting the national brand producer with the manufacturing of its private label facilitates the presence of the private label on the retailer's shelves, an effective cannibalization of sales may arise in the long run if this negatively affects consumers' preference for the national brand.

It would be interesting for further research to incorporate retail competition in the analysis. In particular, retail competition could explain the noticeable emergence of large, specialized manufacturers in the production of private labels.

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A Appendix

A.1 Proof of Lemma 1

With insourcing, it is never optimal to sell only L. Therefore, we show that it is more profitable to sell only B than both B and L.

If only B is sold, the industry profit is $(v + \lambda\delta + k_B)^2/4 - k_B^2/2$, the maximum of which is $\Pi_B^I = (v + \lambda\delta)^2/2$.

If B and L are sold, the industry profit is: $\lambda(v+\delta+k_B)^2/4-k_B^2/2 +(1-\lambda)(v+k_L)^2/4-k_L^2/2$, the maximum of which is $\Pi_{BL}^I = \frac{\lambda}{2(2-\lambda)}(v+\delta)^2 + \frac{1-\lambda}{2(1+\lambda)}v^2$.

Then, let us show that for $\lambda \in (0,1)$:

$$(v + \lambda\delta)^2 - \frac{\lambda}{2-\lambda}(v+\delta)^2 - \frac{1-\lambda}{1+\lambda}v^2 > 0$$

The derivative w.r.t. to δ gives:

$$\frac{2\lambda}{2+\lambda}\left[(2+\lambda)(v+\lambda\delta) - (v+\delta)\right] = \frac{2\lambda}{2+\lambda}(1-\lambda)\left[v - (1-\lambda)\delta\right] > 0 \text{ (for } \delta < v)$$

The difference between the two profits is increasing w.r.t. to δ (for $\lambda \in (0,1)$) and is strictly positive for $\delta = 0$. Therefore, it is always profitable to sell only B with a quality $v + \lambda\delta$ rather than to sell both B and L.

A.2 Proof of Lemma 2

Let us first prove that P chooses similar qualities $k_B^O = k_L^O$.

Assume that P sets qualities for the two goods in a two-stage process: first, P sets a level of investment k for a cost $C(k)$; second, P chooses for good i a level of quality $k_i \leq k$.

In the second stage of this process, given k, P maximizes $(1-\alpha)\pi(k_L, k_B)$, subject to $k_B \leq k$ and $k_L \leq k$. The monopoly revenue $\pi(k_L, k_B)$ is increasing w.r.t. both qualities (see eq. (1)). Therefore, the gross profit of the producer is increasing w.r.t. both qualities and the profit maximizing qualities are $k_L = k_B = k$. Furthermore, if the two goods have identical qualities they are both sold because $k - \delta < k \leq \sqrt{(k+v)^2 + \delta^2\lambda} - v$.

A.3 Proof of Proposition 1

The producer maximizes $\Pi_P^O(k,k)$. From the expression of P's profit (4), it chooses $k_B^O = k_L^O = (v+\lambda\delta)(1-\alpha)/(1+\alpha)$. Profits are then:

$$\Pi_P^O = \tfrac{(1-\alpha)}{4}\left[2\tfrac{(\delta\lambda+v)^2}{1+\alpha} + \delta^2(1-\lambda)\lambda - v^2\right];\ \Pi_R^O = \tfrac{(1-\alpha)}{4}v^2 + \tfrac{\alpha}{4}\left[4\tfrac{(\delta\lambda+v)^2}{(1+\alpha)^2} + \delta^2(1-\lambda)\lambda\right].$$

A.4 Proof of Lemma 3

Equilibrium quality investments in the insourcing subgame. R maximizes $\Pi_R^I(k_L,k_B)$ w.r.t. k_L and P maximizes $\Pi_P^I(k_L,k_B)$ w.r.t. k_B. The function $\pi(k_L,k_B)$ is continuous, differentiable by part and concave by part w.r.t. k_B and k_L. In equilibrium either both goods are sold or only one of them is sold. Therefore, any equilibrium is of one of three types. Furthermore, the corresponding first order conditions are satisfied (there is no corner solution because in each corner, one of the two firms' gross profit is zero).

1. **One candidate, denoted (L), is such that the private label only is sold.** Equilibrium investment is thus $k_L^L = v$, and P does not invest. $k_B^L = 0$, and profits are

$$\Pi_R^L = v^2/2;\ \text{and}\ \Pi_P^L = 0$$

2. **Another candidate, denoted (BL), is such that both goods are sold.** R sets $k_L^{BL} = v\frac{1-\alpha\lambda}{1+\alpha\lambda}$, and P sets $k_B^{BL} = (v+\delta)\frac{(1-\alpha)\lambda}{2-(1-\alpha)\lambda}$. The corresponding equilibrium profits are :

$$\Pi_R^{BL} = (1-\lambda\alpha)\tfrac{v^2}{2(1+\alpha\lambda)} + \lambda\alpha\left[\tfrac{(v+\delta)}{2-(1-\alpha)\lambda}\right]^2;\ \text{and}\ \Pi_P^{BL} = \lambda(1-\alpha)\left[\tfrac{(v+\delta)^2}{2(2-(1-\alpha)\lambda)} - \tfrac{v^2}{(1+\lambda\alpha)^2}\right]$$

NB: for each firm's profit, the first term comes from its own investment in quality, and the second term comes from its rival's investment.

3. **Another candidate, denoted (B), is such that only the national brand is sold.** R sets $k_L^B = v\frac{1-\alpha}{1+\alpha}$, and P sets $k_B^B = (v+\lambda\delta)\frac{1-\alpha}{1+\alpha}$. The equilibrium profits are:

$$\Pi_R^B = (1-\alpha)\tfrac{v^2}{2(1+\alpha)} + \alpha\left[\tfrac{v+\lambda\delta}{1+\alpha}\right]^2;\ \text{and}\ \Pi_P^B = (1-\alpha)\left[\tfrac{(v+\lambda\delta)^2}{2(1+\alpha)} - \tfrac{v^2}{(1+\alpha)^2}\right]$$

Existence of equilibria We determine the domains of existence of equilibria (L), (BL) and (B). First, we check that the corresponding qualities are consistent with the goods sold (see eq. (1)). Then, we consider potential deviations of firms.

For a firm producing good $i = L, B$, for a given quality of its rival, the quality that maximizes its profit is one of the three qualities k_i^L, k_i^{BL}, and k_i^B because they correspond to the three *possible* local maxima. Therefore, for each equilibrium candidate, there are four deviations, two for each firm, that should be verified. For a deviation we write that it is "possible" if the quality is consistent with the goods sold (*i.e.,* if it corresponds to an actual local maximum). We determine conditions under which, first, a deviation is possible and, second, it is profitable. We only mention the former condition when it is stronger than the latter.

Existence of (L): Whenever
$\delta \le \delta_2 = v \min\left\{\left(\frac{2}{\sqrt{1+\alpha\lambda}} - 1\right), \left(\sqrt{2(2-\lambda+\alpha\lambda)} - 1\right), \left(\sqrt{2(1+\alpha)} - 1\right)/\lambda\right\}$.

▷ First, L is the sole good sold if $\delta < k_L^L - k_B^L = v$, which is always true.

• Potential deviation of R by setting k_L^{BL} is not profitable iff $\Pi_R^L < \Pi_R^I(k_B^L, k_L^{BL}) = \lambda\alpha\frac{(v+\delta)^2}{4} + (1-\lambda\alpha)\frac{v^2}{2(1+\lambda\alpha)}$, *i.e.*, $\delta < v\left(2/\sqrt{1+\alpha\lambda} - 1\right)$.

• Potential deviation of R by setting k_L^B is not possible. By eq. (1), if $k_B = 0$ then B is never sold alone.

• Potential deviation of P by investing k_B^{BL} is not profitable iff $\Pi_P^I(k_L^L, k_B^{BL}) = (1-\alpha)[\frac{(v+\delta)^2}{2(2-(1-\alpha)\lambda)} - v^2] < 0$, *i.e.*, $\delta \le v\sqrt{2(2-(1-\alpha)\lambda)} - v$.

• Potential deviation of P by setting k_B^B is not profitable iff $0 \ge \Pi_P^I(k_B^B, k_L^L) = \lambda(1-\alpha)[\frac{(v+\lambda\delta)^2}{2(1+\alpha)} - v^2]$, *i.e.*, $\delta \le v(\sqrt{2(1+\alpha)} - 1)/\lambda$.

Existence of (BL) whenever $\delta \ge \delta_1 = v\max\{\frac{2-(1-\alpha)\lambda}{\sqrt{1+\alpha\lambda}} - 1, \frac{\sqrt{2(2-(1-\alpha)\lambda)}}{1+\alpha\lambda} - 1\}$, or:

$$\delta \le \min\{\frac{v\left(1-\alpha-\sqrt{X}\right)}{1+\alpha-\lambda(1-\alpha)}, \frac{2v((1-\alpha-(2-\lambda(1-\alpha))\sqrt{Y})}{4-(5-\alpha)(1-\alpha)\lambda+(1-\alpha)^2\lambda^2}\} \text{ or } \delta \ge \max\{\frac{v\left(1-\alpha+\sqrt{X}\right)}{1+\alpha-\lambda(1-\alpha)}, \frac{2v((1-\alpha+(2-\lambda(1-\alpha))\sqrt{Y})}{4-(5-\alpha)(1-\alpha)\lambda+(1-\alpha)^2\lambda^2}\},$$

with $X = \frac{(1+\alpha)(2-\lambda(1-\alpha))\left(-1-2\alpha+2\lambda+\alpha^2\lambda^2\right)}{\lambda(1+\alpha\lambda)^2}$ and $Y = \frac{(1-\alpha)^2\lambda(2-\lambda)-(3-\alpha)(1-\lambda)}{(1+\alpha)\lambda(1+\alpha\lambda)}$.

The last two conditions concern only cases in which $X > 0$ and $Y > 0$. If only X is positive then they are reduced to $\delta \le \frac{v\left(1-\alpha-\sqrt{X}\right)}{1+\alpha-\lambda(1-\alpha)}$ or $\delta \ge \frac{v\left(1-\alpha+\sqrt{X}\right)}{1+\alpha-\lambda(1-\alpha)}$; similarly if only $Y > 0$. Note that we have:

- if $\lambda < 1/2$, then $X < 0$ and $Y < 0$.
- if $\lambda \in [1/2, \frac{1}{2}\left(5-\sqrt{13}\right))$, then $Y < 0\ \forall\alpha$, and $X > 0 \Leftrightarrow 0 < \alpha < \frac{1-\sqrt{(1-\lambda)(1+\lambda+2\lambda^2)}}{\lambda^2}$.
- if $\lambda \in [\frac{1}{2}\left(5-\sqrt{13}\right), 0.906)$, then: $X > 0$ and $Y > 0$ if $0 < \alpha < \frac{1-5\lambda+2\lambda^2+\sqrt{(1-\lambda)(1+15\lambda-8\lambda^2)}}{2(-2+\lambda)\lambda}$; $X > 0$ and $Y < 0$ if $\frac{1-5\lambda+2\lambda^2+\sqrt{(1-\lambda)(1+15\lambda-8\lambda^2)}}{2(-2+\lambda)\lambda} \le \alpha < \frac{1}{\lambda^2} - \sqrt{\frac{1+\lambda^2-2\lambda^3}{\lambda^4}}$; and $X < 0$ and $Y < 0$ otherwise.
- If $\lambda \in [0.906, 1]$, then: $X > 0$ and $Y > 0$ if $0 < \alpha < \frac{1}{\lambda^2} - \sqrt{\frac{1+\lambda^2-2\lambda^3}{\lambda^4}}$; $Y > 0$ and $X < 0$ if $\frac{1}{\lambda^2} - \sqrt{\frac{1+\lambda^2-2\lambda^3}{\lambda^4}} \le \alpha < \frac{1-5\lambda+2\lambda^2+\sqrt{(1-\lambda)(1+15\lambda-8\lambda^2)}}{2(-2+\lambda)\lambda}$; $X < 0$ and $Y < 0$ otherwise.

In the following, we explain how we obtain these thresholds.

▷ First, this equilibrium may exist iff $(v + k_B^{BL})^2 < (k_L^{BL} + v)^2 + \lambda\delta^2$, so that both goods are sold, which is true in the area where there is no profitable deviation.

• Potential deviation of P by setting $k_B^L = 0$ is not profitable iff $\Pi_P^{BL} \ge 0$, *i.e.* $\delta \ge v\left(\frac{\sqrt{2(2-(1-\alpha)\lambda)}}{(1+\alpha\lambda)} - 1\right)$.

- Potential deviation of P by setting k_B^B is not profitable iff $\Pi_P^{BL} \geq \Pi_P^I(k_L^{BL}, k_B^B) = (1-\alpha)[\frac{(v+\lambda\delta)^2}{2(1+\alpha)} - \frac{v^2}{(1+\lambda\alpha)^2}]$. This comparison leads to a second-order polynomial function. The deviation is not profitable for extreme values of δ: $\delta \leq \frac{v}{1+\alpha-\lambda+\alpha\lambda}\left(1-\alpha-\sqrt{X}\right)$, or $\delta \geq \frac{v}{1+\alpha-\lambda+\alpha\lambda}\left(1-\alpha+\sqrt{X}\right)$.

- Potential deviation of R by setting k_L^B is not profitable iff $\Pi_R^{BL} \geq \Pi_R^I(k_L^B, k_B^{BL}) = (1-\alpha)\frac{v^2}{2(1+\alpha)} + \alpha\frac{(v+\lambda\delta+k_B^{BL})^2}{4}$; that is, iff:

  $\delta \leq \frac{2v}{4-(5-\alpha)(1-\alpha)\lambda+(1-\alpha)^2\lambda^2}(1-\alpha-(2-\lambda(1-\alpha))\sqrt{Y})$, or $\delta \geq \frac{2v}{4-(5-\alpha)(1-\alpha)\lambda+(1-\alpha)^2\lambda^2}(1-\alpha+(2-\lambda(1-\alpha))\sqrt{Y})$.

- Potential deviation of R by setting k_L^L is not profitable iff $\Pi_R^{BL} \geq \Pi_R^I(k_L^L, k_B^{BL}) = \frac{v^2}{2}$. This arises if $\delta \geq v\left(\frac{(2-(1-\alpha)\lambda)}{\sqrt{1+\alpha\lambda}} - 1\right)$.

Existence of (B): Whenever $\lambda > \frac{\sqrt{17}-3}{2}$, $\alpha < 2\lambda - 1$ and $\delta \in [\delta_2, \delta_3]$, with:

$$\begin{aligned}
\delta_2 &= v \max\left\{\frac{1}{1+\alpha-\lambda(1-\alpha)}\left(1-\alpha-\sqrt{\frac{(\alpha-1)(1+\alpha-2\lambda)(2-\lambda+\alpha\lambda)}{(1+\alpha)\lambda}}\right), \frac{1}{\lambda}\left(\sqrt{\frac{2}{(1+\alpha)}}-1\right),\right. \\
&\quad \left.\frac{2}{(1+\alpha)^2-(1-\alpha)^2\lambda}\left(1-\alpha-\sqrt{\frac{(1+\alpha)\left(-\alpha-\alpha^2+\lambda-\alpha\lambda+2\alpha^2\lambda\right)}{\lambda(1+\alpha\lambda)}}\right), \min\left\{\frac{2\alpha}{1+\alpha+\lambda-\alpha\lambda}, \frac{\sqrt{1+\alpha}-1}{\lambda}\right\}\right\}, \\
\delta_3 &= v \min\left\{\frac{1}{1+\alpha-\lambda(1-\alpha)}\left(1-\alpha+\sqrt{\frac{(\alpha-1)(1+\alpha-2\lambda)(2-\lambda+\alpha\lambda)}{(1+\alpha)\lambda}}\right),\right. \\
&\quad \left.\frac{2}{(1+\alpha)^2-(1-\alpha)^2\lambda}\left(1-\alpha+\sqrt{\frac{(1+\alpha)\left(-\alpha-\alpha^2+\lambda-\alpha\lambda+2\alpha^2\lambda\right)}{\lambda(1+\alpha\lambda)}}\right)\right\}
\end{aligned}$$

▷ First this equilibrium may exist iff $k_B^B > \sqrt{(k_L^B+v)^2+\lambda\delta^2} - v$, or equivalently $\delta < \frac{4(1-\alpha)v}{(1+\alpha)^2-(1-\alpha)^2\lambda}$. This condition is always verified when $\delta \in [\delta_2, \delta_3]$.

- Potential deviation of P by setting k_B^{BL} is profitable iff $\Pi_P^B \geq \Pi_P(k_L^B, k_B^{BL}) = \lambda(1-\alpha)\left[\frac{(v+\delta)^2}{2(2-(1-\alpha)\lambda)} - \frac{v^2}{(1+\alpha)^2}\right]$. Thus, there is no profitable deviation for P toward (BL) if $\alpha < -1+2\lambda$ and $\delta \in [\frac{v}{1+\alpha-\lambda(1-\alpha)}(1-\alpha-\sqrt{\frac{(\alpha-1)(1+\alpha-2\lambda)(2-\lambda+\alpha\lambda)}{(1+\alpha)\lambda}}), \frac{v}{1+\alpha-\lambda(1-\alpha)}(1-\alpha+\sqrt{\frac{(\alpha-1)(1+\alpha-2\lambda)(2-\lambda+\alpha\lambda)}{(1+\alpha)\lambda}})]$. This set is not in $[0, v]$ if λ is sufficiently low, that is, for $\lambda < \frac{\sqrt{17}-3}{2}$ this deviation is always profitable, and there is no equilibrium of type (B).

- Potential deviation of P by setting $k_B^L = 0$ is not profitable iff $\Pi_P^B \geq 0$; *i.e.,* $\delta > \frac{v}{\lambda}\left(\sqrt{\frac{2}{(1+\alpha)}}-1\right)$.

- Potential deviation of R by setting k_L^{BL} is not profitable iff $\Pi_R^B \geq \Pi_R^I(k_L^{BL}, k_B^B) = (1-\lambda\alpha)\frac{v^2}{2(1+\lambda\alpha)} + \lambda\alpha\frac{(v+\lambda\delta+k_B^B)^2}{4}$. Thus, this deviation is not profitable iff $0 < \alpha <$

$\frac{1+\lambda-\sqrt{1+6\lambda-7\lambda^2}}{2(-1+2\lambda)}$ and:

$$\delta \in \left[\frac{2v}{(1+\alpha)^2-(1-\alpha)^2\lambda}\left(1-\alpha-\sqrt{\frac{(1+\alpha)\left(-\alpha-\alpha^2+\lambda-\alpha\lambda+2\alpha^2\lambda\right)}{\lambda(1+\alpha\lambda)}}\right),\right.$$
$$\left.\frac{2v}{(1+\alpha)^2-(1-\alpha)^2\lambda}\left(1-\alpha+\sqrt{\frac{(1+\alpha)\left(-\alpha-\alpha^2+\lambda-\alpha\lambda+2\alpha^2\lambda\right)}{\lambda(1+\alpha\lambda)}}\right)\right].$$

- Potential deviation of R by setting k_L^L is possible as long as $k_L^L-\delta > k_B^B$ or, equivalently, $\delta < \frac{2\alpha v}{1+\alpha+\lambda(1-\alpha)}$. It is profitable if $\Pi_R^B < \Pi_R^I(k_L^L, k_B^B) = \frac{v^2}{2}$. Thus, when $\delta > \min\left\{\frac{2v\alpha}{1+\alpha+\lambda-\alpha\lambda}, \frac{v\left(\sqrt{1+\alpha}-1\right)}{\lambda}\right\}$, there is no profitable deviation for R toward (L).

A.5 Proof of Proposition 3

We analyze the derivative of $\Delta_{O,I}$ w.r.t. α and δ. To do so, we first determine the derivatives of the industry profit with outsourcing and insourcing.

With outsourcing, the industry profit is $\Pi^O = \pi(k_B^O, k_B^O) - C(k_B^0)$

- The quality investment satisfies the first-order condition $(1-\alpha)(\frac{\partial\pi}{\partial k_B}+\frac{\partial\pi}{\partial k_L}) = C'(k_B^O)$.
- The derivative of the industry profit w.r.t. α is:

$$\begin{aligned}\frac{d\Pi^O}{d\alpha} &= \left(\frac{\partial\pi}{\partial k_B}+\frac{\partial\pi}{\partial k_L}-C'(k_B^O)\right)\frac{\partial k_B^O}{\partial\alpha},\\ &= \frac{\alpha}{1-\alpha}C'(k_B^O)\frac{\partial k_B^O}{\partial\alpha}, \qquad \text{injecting the F.O.C.,}\\ &= \frac{\alpha}{1-\alpha}k_B^O\frac{\partial k_B^O}{\partial\alpha} < 0. \end{aligned} \tag{9}$$

With insourcing, the profit of the industry is $\Pi^I = \pi(k_B^I, k_L^I) - C(k_B^I) - C(k_L^I)$.

- When the brand is sold (equilibra B and BL):
  - The two quality investments satisfy:

$$(1-\alpha)\frac{\partial\pi}{\partial k_B} - C'(k_B^I) = 0 \text{ and } \frac{\partial\pi}{\partial k_L} + (1-\alpha)\left(\frac{\partial\bar{\pi}}{\partial k_L}-\frac{\partial\pi}{\partial k_L}\right) - C'(k_L^I) = 0.$$

    the second term of the F.O.C. related to k_L is positive explaining the over-investment in k_L.
  - The derivative of the industry profit is:

$$\begin{aligned}\frac{d\Pi^I}{d\alpha} &= \left(\frac{\partial\pi}{\partial k_B}-C'(k_B^I)\right)\frac{\partial k_B^I}{\partial\alpha} + \left(\frac{\partial\pi}{\partial k_L}-C'(k_L^I)\right)\frac{\partial k_L^I}{\partial\alpha},\\ &= \underbrace{\frac{\alpha}{1-\alpha}k_B^I\frac{\partial k_B^I}{\partial\alpha}}_{<0 \text{ hold-up effect aggravation}} + \underbrace{(1-\alpha)\left(\frac{\partial\bar{\pi}}{\partial k_L}-\frac{\partial\pi}{\partial k_L}\right)\frac{-\partial k_L^I}{\partial\alpha}}_{>0 \text{ outside-option effect reduction}}.\end{aligned} \tag{10}$$

The second term is positive; the outside-option effect is softened when α increases. The first term is negative; the hold-up is aggravated when α increases.

- When only L is sold, the quality investment does not depend on α. Therefore, the derivative of the industry profit is $\frac{d\Pi^I}{d\alpha} = 0$.

When the two goods are sold with insourcing, the difference between the two profits $\Delta_{O,I}$ is decreasing w.r.t. α:

$$\frac{d\Delta_{O,I}}{d\alpha} = \underbrace{\frac{\alpha}{1-\alpha}\left[k_B^O\frac{\partial k_B^O}{\partial\alpha} - k_B^I\frac{\partial k_B^I}{\partial\alpha}\right]}_{\text{Comparison of the reduction of hold-up effects}} + (1-\alpha)\left(\frac{\partial\bar{\pi}}{\partial k_L} - \frac{\partial\pi}{\partial k_L}\right)\frac{\partial k_L^I}{\partial\alpha}. \tag{11}$$

The second term is negative. We show with the explicit expressions of qualities that the bracketed term is negative:

$$k_B^O = (v+\lambda\delta)\frac{1-\alpha}{1+\alpha} \quad \text{and} \quad \frac{\partial k_B^O}{\partial\alpha} = (v+\lambda\delta)\frac{-2}{(1+\alpha)^2}$$

$$k_B^I = \lambda(v+\delta)\frac{(1-\alpha)}{2-\lambda(1-\alpha)} \quad \text{and} \quad \frac{\partial k_B^I}{\partial\alpha} = \lambda(v+\delta)\frac{-2}{(2-\lambda(1-\alpha))^2}$$

and $\lambda(v+\delta) < v+\lambda\delta$ and $2-\lambda(1-\alpha) > 2-(1-\alpha) = 1+\alpha$. Therefore, the bracketed term in eq. (11) is negative, and $d\Delta_{O,I}/d\alpha < 0$. $\Delta_{O,I}$ is positive at $\alpha = 0$ and negative at $\alpha = 1$; therefore, there exists a unique threshold denoted α^{**} such that $\Delta_{O,I} > 0$ when $\alpha < \alpha^{**}$.

When only the private label is sold with insourcing, the difference between the two profits $\Delta_{O,I}$ is decreasing w.r.t. α: $d\Delta_{O,I}/d\alpha = d\Pi^O/d\alpha < 0$. $\Delta_{O,I}$ is positive at $\alpha = 0$ and negative at $\alpha = 1$, therefore there exists a unique threshold denoted α^* such that $\Delta_{O,I} > 0$ when $\alpha < \alpha^*$.

Monotonicity of the thresholds w.r.t. δ We show that the comparison $\Delta_{O,I}$ is increasing w.r.t. to δ:

$$\begin{aligned}\frac{d\Delta_{O,I}}{d\delta} &= \frac{\partial\Delta_{O,I}}{\partial\delta} + \frac{\partial\Pi^O}{\partial k_B^O}\frac{\partial k_B^O}{\partial\delta} + \frac{\partial\Pi^I}{\partial k_B^I}\frac{\partial k_B^I}{\partial\delta} + \frac{\partial\Pi^I}{\partial k_B^I}\frac{\partial k_L^I}{\partial\delta}, \\ &= \frac{\partial\Delta_{O,I}}{\partial\delta} + \frac{\alpha}{1-\alpha}\left[k_B^0\frac{\partial k_B^O}{\partial\delta} - k_B^I\frac{\partial k_B^I}{\partial\delta}\right] + 0, \\ &= \frac{\lambda}{2}(k_B^O - k_B^I) + \frac{\alpha}{1-\alpha}\left[k_B^O\frac{\partial k_B^O}{\partial\delta} - k_B^I\frac{\partial k_B^I}{\partial\delta}\right].\end{aligned} \tag{12}$$

When only L is sold with insourcing, $k_B^I = 0$ and $\frac{\partial k_B^O}{\partial\delta} > 0$, and thus, $\frac{d\Delta_{O,I}}{d\delta} > 0$. When both goods are sold, $k_B^O > k_B^I$ and:

$$k_B^O\frac{\partial k_B^O}{\partial\delta} = \lambda(v+\lambda\delta)\frac{(1-\alpha)^2}{(1+\alpha)^2} \quad \text{and} \quad k_B^I\frac{\partial k_B^I}{\partial\delta} = \lambda^2(v+\delta)\frac{(1-\alpha)^2}{(2-\lambda(1-\alpha))^2}.$$

Again, becuase $\lambda(v+\delta) < v+\lambda\delta$ and $2-\lambda(1-\alpha) > 1+\alpha$, the bracketed term in eq. (12) is positive, and $d\Delta_{O,I}/d\delta > 0$. For a given value of α, $\Delta_{O,I}$ is increasing w.r.t. δ; therefore, both thresholds α^* and α^{**} are increasing in δ.

A.6 Proof of Proposition 4

Equilibrium (B). We know that $k_B^B = k^O$. In this case, outsourcing creates discrimination among consumers without increasing qualities, which always decreases consumer surplus.

Equilibrium (L). With the quadratic specification, the consumer surplus for given qualities is half the profit π. The difference between surpluses S^O and S^I is then equal to

$$\Delta_{O,I}^S = \frac{1}{2}\Delta_{O,I} + \frac{1}{2}(C(k_B^O) - C(k_L^L)).$$

First, $\Delta_{O,I}$ and k_B^O are strictly decreasing w.r.t. α, and k_L^L is constant w.r.t. α. Therefore, $\Delta_{O,I}^S$ is strictly decreasing w.r.t. α.

Second, when $\alpha = 0$, $\Delta_{O,I}^S > 0$ because $\Delta_{O,I} > 0$ and $k_B^O = v + \lambda\delta > k_L^L = v$. When $\alpha = \alpha^*$, $\Delta_{O,I} = 0$. Moreover, $k_B^O(\alpha^*) < k_L^L$. Let α_g be such that $k_L^L = k^O(\alpha_g)$. In $k_L^L = k^O(\alpha_g)$, $\Delta_{O,I} > 0$ because with outsourcing, the retailer can discriminate without additional cost and therefore can generate an additional revenue on the national brand. Because $\Delta_{O,I}$ is strictly decreasing in α, $\alpha_g < \alpha^*$, and because $k^O(\alpha)$ is strictly decreasing in α, we have $k_B^O(\alpha^*) < k_L^L$. Consequently, $C(k_B^O) - C(k_L^L) < 0$ for $\alpha = \alpha^*$, and therefore, $\Delta_{O,I}^S < 0$ for $\alpha = \alpha^*$.

From the monotonicity of $\Delta_{O,I}^S$, there exists a threshold $\hat{\alpha}^* < \alpha^*$ such that outsourcing increases the consumer surplus if and only if $\alpha < \hat{\alpha}^*$.

Equilibrium (BL). A similar reasoning can be applied. The difference between surpluses S^O and S^I is $\Delta_{O,I}^S = \frac{1}{2}\Delta_{O,I} + \frac{1}{2}(C(k_B^O) - C(k_L^{BL}) - C(k_B^{BL}))$.

First, the difference of consumer surplus is decreasing w.r.t. α (proven below). Second, when $\alpha = 0$, $\Delta_{O,I}^S > 0$ (both qualities are lower with insourcing than with outsourcing). When $\alpha = \alpha^{**}$, $\Delta_{O,I} = 0$ and $k_B^O < k_L^{BL}$ (proven below). As a consequence, $C(k_B^O) - C(k_L^{BL}) - C(k_B^{BL}) < C(k_B^O) - C(k_L^{BL}) < 0$, and therefore, $\Delta_{O,I}^S < 0$ for $\alpha = \alpha^{**}$.

The two missing proofs:

Proof. $\Delta_{O,I}^S$ is decreasing w.r.t. α:

The derivative of the consumer surpluses w.r.t. α are:

- with outsourcing (using the first order conditions and the explicit expression of k_B^O):

$$\frac{dS^O}{d\alpha} = \frac{1}{4}[\lambda(v + \delta + k_B^O) + (1-\lambda)(v + k_B^O)]\frac{\partial k_B^O}{\partial\alpha} = \frac{1}{2}\frac{k_B^O}{1-\alpha}\frac{\partial k_B^O}{\partial\alpha} = -\frac{(v+\lambda\delta)^2}{(1+\alpha)^3}$$

- with insourcing:

$$\frac{dS^I}{d\alpha} = \frac{1}{4}[\lambda(v+\delta+k_B^I)\frac{\partial k_B^I}{\partial\alpha} + (1-\lambda)(v+k_L^I)\frac{\partial k_L^I}{\partial\alpha} = \frac{1}{2}\frac{k_B^I}{1-\alpha}\frac{\partial k_B^I}{\partial\alpha} + \frac{1}{2}\frac{(1-\lambda)k_L^I}{1-\alpha\lambda}\frac{\partial k_L^I}{\partial\alpha}$$
$$= -\frac{\lambda^2(v+\delta)^2}{(2-\lambda(1-\alpha))^3} - \frac{(1-\lambda)\lambda v^2}{(1+\alpha\lambda)^3}$$

Then, the derivative of the comparison is decreasing w.r.t. δ so it is lower than

$$v^2\left[\frac{\lambda^2}{(2-\lambda(1-\alpha))^3}+\frac{(1-\lambda)\lambda}{(1+\alpha\lambda)^3}-\frac{1}{(1+\alpha)^3}\right].$$

We have to show that the bracketed factor is negative. The first two terms show the effect of α on consumer surpluses, brand lovers and standard consumers, with insourcing, and the last one shows the effect with outsourcing. The comparison is not straightforward. Using $2-\lambda(1-\alpha)>1+\alpha$, the bracketed factor above is lower than

$$\frac{(1-\lambda)\lambda}{(1+\alpha\lambda)^3}-\frac{1-\lambda^2}{(1+\alpha)^3}=\frac{1-\lambda}{(1+\alpha\lambda)^3}\left[\lambda-(1+\lambda)\left(\frac{1+\alpha\lambda}{1+\alpha}\right)^3\right]<\frac{1-\lambda}{(1+\alpha\lambda)^3}\left[\lambda-(1+\lambda)^4/8\right].$$

and the last bracketed factor is negative. It is maximized at λ' such that $(1+\lambda')^3=2$. It is then equal to $\lambda'-(1+\lambda')/4=3(\lambda'-1/3)$ and $\lambda'<1/3$ (because $(1+1/3)^3=64/27>2$). Therefore, the comparison of consumers surplus is decreasing w.r.t. α. □

Proof. $k_B^O<k_L^{BL}$ at $\alpha=\alpha^{**}$:

Let α_g be such that $k_B^O(\alpha_g)=k_L^{BL}(\alpha_g)$. When $\alpha=\alpha_g$, $\Delta_{O,I}>0$ (with outsourcing, the retailer saves the cost of investment on the private label) and because $\Delta_{O,I}$ is decreasing in α, $\alpha^{**}>\alpha_g$. Then, $k_B^O(\alpha)-k_L^{BL}(\alpha)$ is decreasing in α:

$$\frac{\partial k_B^O}{\partial\alpha}-\frac{\partial k_L^{BL}}{\partial\alpha}=-(v+\lambda\delta)\frac{2}{(1+\alpha)^2}+v\frac{2\lambda}{(1+\alpha\lambda)^2}=-2\left(\frac{v(1-\lambda)(1-\alpha^2\lambda)}{(1+\alpha)^2(1+\alpha\lambda)^2}-\frac{\lambda\delta}{(1+\alpha)^2}\right)<0.$$

We have $k_B^O<k_L^{BL}$ for $\alpha=\alpha^{**}$.

□