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DIW Berlin
German Institute for Economic Research
Mohrenstr. 58
10117 Berlin

Tel. +49 (30) 897 89-0
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Buyer Power and the Effect of Vertical Integration on Innovation*

Claire Chambolle† Morgane Guignard ‡

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Abstract

Our article investigates the impact of vertical integration (without foreclosure) on innovation. We compare cases where either (i) two manufacturers or (ii) a manufacturer and a vertically integrated retailer invest. Then, the independent manufacturer(s) and the retailer bargain over non-linear contracts before selling to consumers. We show that vertical integration always increases the incentives to invest on the integrated product which stifles (resp. spurs) the investment of the independent manufacturer when spillovers are low (resp. high). In contrast, when investments are sequential, if the buyer power is high, the leader independent manufacturer invests more (resp. less) to discourage the integrated retailer's investment when spillovers are low (resp. high). Furthermore, vertical integration is always profitable even when it is not desirable for the industry and welfare. Overall, vertical integration is only desirable for the industry when the buyer power is high and may damage welfare when both the buyer power and spillovers are low.

Keywords: Vertical integration, Investment, Buyer power, Spillovers.
JEL classification: L13, L14, L42.

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†Université Paris-Saclay, INRAE, UR ALISS, 94205, Ivry-sur-Seine, France; CREST, École polytechnique;

‡Deutsches Institut für Wirtschaftsforschung (DIW Berlin); mguignard@diw.de

1 Introduction

Vertical mergers have recently regained attention due to concerns about potential anti-competitive outcomes. Critics have been raised about the 2020 US Vertical Merger Guidelines, specifically regarding how the guidelines balanced the potential efficiency gains from vertical integration (i.e, eliminating double marginalization) against the possible harm to competition.[1] A key concern related to possible harm to competition in the context of vertical mergers is the foreclosure of rivals.[2] Although often relegated to the background, the impact of vertical integration on innovation is an important element to consider. The literature focusing on the role of vertical integration on innovation highlights ambiguous effects. On the one hand, vertical integration appears as a solution to alleviate hold-up concerns, thereby fostering an increase in the investment of the vertically integrated entity (see Williamson (1975, 1985) and Grossman and Hart (1986)). On the other hand, these hold-up concerns may increase for independent rivals, potentially leading to a reduction in their investment and consumer welfare (see, e.g., Allain et al. (2016), Loertscher and Riordan (2019), Liu (2016)). Our paper analyzes the balance between the pro- and anti-innovation effects of vertical mergers and its consequences for consumer welfare. We highlight that it crucially depends on the sharing of bargaining powers within the vertical chain also as from the nature of investments (strategic complements /substitutes). Our model deliberately focuses on the pure effect of vertical integration on innovation therefore excluding any consideration related to the elimination of double marginalization or foreclosure concerns.

The development of private labels in the food industry, that is retailers' own brands, illustrates well this issue. Retailers often choose to integrate backward with a manufacturer to produce their private labels.[3] Moreover, the consolidation of the retail sector

[1] https://www.ftc.gov/system/files/documents/reports/us-department-justice-federal-trade-commission-vertical-merger-guidelines/vertical_merger_guidelines_6-30-20.pdf

[2] In particular, it has been argued that efficiencies often can be achieved without merger, that is using contract, and therefore worried that the guidelines might lead to an overly permissive approach to vertical mergers.

[3] Retailers also often rely on small manufacturers with low bargaining power that is tantamount to being vertically integrated (e.g., Chambolle et al. (2015)).

through merger waves[4], buying alliances[5] and most importantly the development of private labels[6] has considerably increased retailers' bargaining power. As pointed out by Chauve and Renckens (2015): "*Retailers' increased bargaining power through private labels could therefore have indirectly influenced the decline in innovation*". Two channels may relate private labels to a decline in innovation. First, by evicting innovative brand products from the retailers' shelves, private labels may have de facto limited innovation. Second, by reinforcing retailer's bargaining power, private labels have raised the hold-up concern for manufacturers which may have indirectly stifled their innovation. Nevertheless, these views can also be challenged. As retailers have also become increasingly innovative with their private labels, their larger presence on the shelves does not necessarily diminish innovation. Furthermore, the presence of more innovative private labels may have pushed manufacturers to innovate further in order to differentiate their brands. Retailers have indeed expanded their private label portfolios and sometimes became major innovators.[7] Indeed, the majority of food innovations are incremental changes that do not require high R&D costs which has allowed retailers to easily take part in the innovation process (FAO (2006)).

This article examines the implications of a shift in innovation activity from manufacturers to retailers through vertical integration. In this analysis, we specifically focus on the influence of retailer's backward vertical integration on investment levels while ruling out any concerns related to foreclosure. In a first vertical structure, two differentiated manufacturers can invest on their respective product. In a second vertical

[4]The world's ten largest retailers captured 30% of the sales of the 250 largest retailers in 2006: http://www.fao.org/fileadmin/user_upload/tci/docs/AH4-Food%20Retail.pdf

In 2018, the highest five-firm concentration ratios (CR5) was: 76% in UK, 78.4% in France, between 50% and 70% in Germany, Spain, and Portugal. The highest fourth-firm concentration ratios (CR4) is around 93% in Sweden, Finland and Denmark (Statista).

[5]For instance, Agecore, created in 2015, is an alliance between Colruyt (Belgium), Conad (Italy), Coop (Switzerland), Edeka (Germany), and Eroski (Spain); Eurelec has been created in 2016 by Leclerc (France) and Rewe (Germany) and Horizon, set up in 2019, is an alliance between Casino and Auchan (France), Dia (Spain), Metro (Germany), Schiever Group (France and Poland).

[6]On average in Europe, the share of private label represented 15% in 2003 and has doubled to reach 32% in 2016. Their sales even reached more than 40% in Spain and United Kingdom in 2016. In North America, the penetration is lower with a share of 16% in 2016: https://www.nielsen.com/wp-content/uploads/sites/3/2019/04/global-private-label-report.pdf

[7]"*Many retailers have developed a whole range of differentiated private labels, from low price products to more expensive high-quality alternatives for A-brands or even completely innovative products (for instance, lactose-free dairy products or gluten-free bread).*" Chauve and Renckens (2015)

structure, the retailer is integrated backward with one of the two manufacturers, and thus both the integrated retailer and the independent manufacturer can invest. After investments take place, the independent manufacturer(s) bargain(s) over non-linear contracts with the retailer which then sells the goods to consumers. In these market structures, the downstream retailer (either integrated or not) fully internalizes the competition among manufacturers and wholesale unit prices are set at marginal cost. Therefore, there is no double marginalization and final prices are set at their optimal level for the industry (monopoly level). Vertical integration thus only induces changes in investments. We allow the manufacturer who always remains independent on the market to play a dominant role in innovation. This means that its investment may generate a positive unilateral technological spillover on its rival's investment. Our analysis is then conducted under two different frameworks, one in which investments are strategic substitutes (due to low spillovers) and another one in which investments are strategic complements (due to high spillovers).

We first show that the integrated retailer's incentive to invest is always larger than that of an independent rival manufacturer. This is the case for two reasons. First, vertical integration solves the hold -up problem, and second the integrated retailer can directly boost its status-quo profit in the negotiation with the manufacturer through its investment. In turn, vertical integration always discourages the independent manufacturer to invest when investments are strategic substitutes (low spillover). However, when investments become strategic complements (high spillover), we show that vertical integration also encourages the independent manufacturer to invest. In that case, the effect of vertical integration on the overall level of innovation is clearly positive.

Our model then shows that vertical integration is only desirable for the industry when the buyer power is high. Indeed, when the buyer power is low, the hold-up effect is rather limited under vertical separation and therefore the investments of both manufacturers are close to the optimum industry level. In contrast, vertical integration distorts upward the investment of the integrated retailer and either downward (low spillovers) or upward (high spillovers) that of the independent manufacturer. When instead the buyer power is large, the two independent manufacturers limit their investments much below their optimal industry level due to a large hold-up effect. In that case, the main effect of vertical integration is to solve this hold-up problem which benefits the industry even if the independent manufacturer is in reaction discouraged from investing. In the linear demand case, derived from a representative consumer quadratic utility, we show that, vertical integration may damage welfare when both the buyer power and spillovers are low. Finally, irrespective of the level of spillovers, we show that the incentive of the retailer to vertically integrate is too high: it is always profitable for the retailer to vertically integrate even when it is not desirable for the industry and welfare.

We then extend our model to allow the independent manufacturer to internalize the spillover it generates on its rival when choosing its investment. To do so, we now assume that it chooses its investment level as a Stackelberg leader. In that framework, vertical integration still spurs the investment on the integrated product and the results obtained in the simultaneous case on the independent manufacturer still hold when the buyer power is low. In contrast, when the buyer power is high, the effect of vertical integration on the independent manufacturer's incentive to invest are now reversed: incentives are higher (resp. lower) when spillovers are low (resp. high). This reversal is due to one major effect which is the incentive of the leading manufacturer to limit the powerful retailer's status-quo in its bargaining. When spillovers are low, the leading manufacturer spurs its investment to dampen in turn the investment of the retailer and thus its status-quo profit. To our knowledge, we are the first to highlight that vertical integration can enhance the incentives to invest of an independent rival. When spillovers are high the manufacturer achieves the same objective by limiting instead its investment. Overall, when we take into account the leading role of independent manufacturer in the innovation process, we find that the level of innovation might decrease with vertical integration in a situation in which the retailer has a strong bargaining power and the spillover is high.

Our article aligns with literature suggesting that vertical integration may be a source of hold-up for the independent rivals which may harm consumers. In line with Allain et al. (2016) who show that partial backward vertical integration may create hold-up for the rival retailer, thereby limiting its innovation, our study reveals that retailer's backward integration similarly generates hold-up for the rival manufacturer.[8] However, in their article the creation of hold-up relies on either an ex-ante commitment on a greedy sharing rule or an ex-post threat of sabotage by the integrated firm. In contrast, in our

[8] Similarly Liu (2016) shows that partial vertical integration may discourage the investment of a rival manufacturer when investments are strategic substitutes. In a more distant context, in which a buyer has imperfect information about suppliers' costs, Loertscher and Riordan (2019) also highlight that vertical integration increases the investment incentive of the integrated firm but decreases that of the other manufacturers.

model the creation of hold-up naturally stems from the increased incentive of the integrated retailer to invest, which raises its status-quo profit toward the independent manufacturer who in turn invests less.[9] Our model however reveals that when spillovers are high, the independent manufacturer invests more under vertical integration.[10] Interestingly, in the extension in which we allow the independent manufacturer to be a leader in innovation, vertical integration may also boost the incentives to invest of the independent manufacturer when spillovers are low. In that case, the independent manufacturer invests more to limit the investment (and status quo profit) of the integrated retailer when the buyer power is large. To our knowledge this mechanism was not previously highlighted in the literature.

Our article also contributes to the literature that analyzes the links between the balance of power in vertically related markets and manufacturers' incentive to innovate. Several articles directly highlight that manufacturers may have larger incentives to invest to enhance their bargaining position vis-à-vis a powerful retailer. For instance Inderst and Wey (2011) show that a manufacturer has a larger incentive to invest in technology to strengthen its cost competitiveness to reduce the status quo of its buyers' when the latter's bargaining power increases in which case it raises consumer surplus.[11] Other articles rather point out the negative impact of buyer power on manufacturer's investment. Battigalli et al. (2007) show that buyer power directly harms manufacturers that obtain a lower share of total profits extracted from the negotiation. This hold-up effect reduces their incentive to engage in quality improvement and hurts consumer welfare. We depart from these articles by allowing, in the vertical integration case, both the manufacturer and the retailer to affect their balance of power through their investments. We show that only the retailer can affect its bargaining position through its investment in a simultaneous game, whereas both the leading manufacturer and the integrated retailer can do so in a sequential game.

The article is organized as follows. Section 2 presents the baseline model assump-

[9] Chambolle et al. (2015) have also highlighted that a retailer producing its private label would overinvest to improve its quality to raise its status-quo in the bargaining with a brand manufacturer.

[10] In set up with complementary investments and a vertical structure with a monopolist selling to two differentiated retailers, Israel and O'Brien (2021) found that vertical integration always increases the integrated firms' investment which often benefit consumers but may harm an independent retailer.

[11] In the same vein, Caprice and Rey (2015) examine the role of joint listing decisions by firms belonging to a buying group. Such a practice increases the bargaining position of buyers and may encourage manufacturers' incentive to invest if the group is not too large by limiting the value of retailers' outside option.

tions and notations. Section 3.1 determines the equilibrium investment under the market structure in which the two manufacturers invest and Section 3.2 under vertical integration. Section 3.3 discusses the optimal market structures regarding industry profit, welfare and merging firms. Section 3.4 explores three major points of our framework: the effect of the baseline quality gap on the average quality level of products offered to consumers, the robustness of our results to linear wholesale contracts and to investment cost asymmetry between the retailer and manufacturers. We analyse in Section 4 a sequential timing in which the independent manufacturer has a leading role in innovation. Section 5 concludes.

2 The Model

We consider an industry in which two manufacturers U_H and U_L sell to a downstream firm D. Products are differentiated and indexed by $Q = \{H, L\}$; U_H produces H and U_L produces L at a constant unit cost normalized to zero.

The primitive profit functions An investment denoted $q = \{h, l\}$ increases the consumers' demand for the product Q through either a quality improvement or an advertising campaign thus increasing the gross industry profit. Note that considering instead a process innovation does not affect our analysis.[12] The industry profit (i.e. the profit of a fully integrated firm) generated by each assortment of products is denoted as follows: $\Pi^Q(q)$ when only product Q is offered on the market and $\Pi^{HL}(h,l)$ when both products H and L are offered on the market.[13] Note that for simplicity we henceforth use a simplified notation Π^Q and Π^{HL} omitting their arguments. We make the following assumptions on these profits:

Assumption A. 1. *Products are imperfect substitutes:*

$$\Pi^L \leq \Pi^H < \Pi^{HL} < \Pi^H + \Pi^L.$$

[12] It is often the case in the literature on mergers that process innovation and quality improving investments lead to different conclusions because the merger also triggers a price effect (Jullien and Lefouili, 2018). In our model, vertical integration does not affect prices as the downstream monopolist internalizes the competition externality in both markets structures.

[13] These primitive profit functions derive from basic assumptions of demand (see Appendix A for details).

Assumption A.1 implies in our model that D always offers both H and L in equilibrium. Under Assumption A.1, vertical integration never leads to upstream foreclosure.

INVESTMENT The investment cost $c(q)$, with $c'(q) > 0$ and $c''(q) > 0$, is fixed (i.e. does not vary with the quantity produced) and is identical for all firms. We make the following assumptions:

Assumption A. 2. *The marginal return of investment is positive and is larger when a single product Q is sold on the market rather than when both products are sold:*

$$\frac{\partial \Pi^Q}{\partial q} > \frac{\partial \Pi^{HL}}{\partial q} > 0.$$

Assumption A. 3. *The marginal return of investment is increasing:*

$$\frac{\partial^2 \Pi^Q}{\partial q^2} > 0, \frac{\partial^2 \Pi^{HL}}{\partial q^2} > 0.$$

Assumption A. 4. *The marginal return of a given product investment further decreases with the investment on the other product:*

$$\frac{\partial^2 \Pi^{HL}}{\partial h \partial l} = \frac{\partial^2 \Pi^{HL}}{\partial l \partial h} < 0.$$

Assumption A.4 implies that investments are strategic substitutes.

We denote the total net industry profit when the two products are sold by:

$$\Pi^O \equiv \Pi^{HL} - c(h) - c(l).$$

Similarly, the total industry profit when only product Q is sold is:

$$\bar{\Pi}^O \equiv \Pi^Q - c(q).$$

We further add the following assumption:

Assumption A. 5. *Total net industry profits Π^O and $\bar{\Pi}^O$ are concave in investment(s).*

We show in Appendix B that Assumption A.5 also ensures that each firm's net profit function is concave in its own investment q.

Assumptions A.1 to A.5 are verified in basic models of demand for differentiated products (see e.g. Mussa and Rosen (1978) and Shubik and Levitan (1980)).

In what follows, we allow the investment on product H to exert a positive technological spillover on the quality level of product L (one-way spillover). Therefore, we assume the presence of a dominant manufacturer in the innovation process, that is U_H.[14] As mentioned in the literature, technological spillover can be seen as an imitation of manufacturer's innovation, to some extent, by a competitor (d'Aspremont and Jacquemin (1988), Jullien and Lefouili (2018)). It might be frequent for products where innovation is not protected by intellectual property rights.

Formally, we assume that $\lambda \equiv l + \beta h$ where the parameter $\beta \geq 0$ reflects the intensity of the spillover and λ is the resulting quality of product L. We consider in turn that β is zero or low to illustrate a case where investments are strategic substitutes, and a case where β is high enough to ensure that investments are strategic complements. In what follows the industry profit function when the two products are sold is $\Pi^{HL}(h, \lambda)$. For clarity, we keep omitting arguments, i.e. Π^{HL} refers here to $\Pi^{HL}(h, \lambda)$. This simple notation is convenient because $\frac{\partial \Pi^{HL}(h, l+\beta h)}{\partial l} = \frac{\partial \Pi^{HL}(h,\lambda)}{\partial \lambda}$.

Market Structure We compare two market structures. The first one in which both U_H and U_L innovate on their respective product and are independent from the retailer D (hereafter, "Vertical separation" case). In the second one, U_L and D are vertically integrated to form a new entity denoted I. Here, U_H and I innovate (hereafter, "Vertical integration" case). We often refer to I as a retailer that invests on its private label.[15]

Timing of the game We consider the following three stage game:

[14] In practice, we often observe that a dominant firm tends to have large $R\&D$ expenditures or fewer financial constraint.

[15] According to the Private Label Manufacturer Association, the vast majority of private labels are directly produced by the retailer or produced by small- and medium-sized firms dedicated to the retailer which supports our vertical integration assumption. An investigation report for the Assemblée Nationale in 2019, in France states that 98% of private labels are produced by SME's, see https://www.assemblee-nationale.fr/dyn/15/rapports/cegrdist/l15b2268-t1_rapport-enquete#_ftn65.

- Stage 1: Firms choose simultaneously their investments. These decisions are observed by all.

- Stage 2: Bargaining over a two-part tariff between the retailer and the manufacturer(s).

- Stage 3: The retailer sets its final price(s) and sells to consumers.

We now comment the stage game. Note first that stages 2 and 3 can be united in a single stage in which each manufacturer-retailer pair bargains over a lump-sum tariff to share the optimal industry profit. Indeed, Bernheim and Whinston (1985); O'Brien and Shaffer (2005) have shown that competing manufacturers can use the common agent D as a coordination device to replicate a collusive outcome and maximize the industry profit regardless of the distribution of bargaining power in the vertical chain.[16] As a result, bilateral efficiency (i.e. cost-based wholesale contracts) always prevails in Stage 2 and therefore in a Stage 3 D always set prices to maximize the industry profit. Therefore, stages 2 and 3 are equivalent to a single stage in which manufacturer(s) bargain with the retailer over a lump-sum tariff to split the industry profit. In the bargaining stage, we consider an asymmetric Nash-in Nash bargaining framework à la Horn and Wolinsky (1988) with a bargaining power $\alpha \in [0,1]$ for each U_Q and $(1-\alpha)$ for D. In what follows we look for the subgame perfect Nash equilibria of this game.

3 Vertical Integration and Investments

We first solve in Section 3.1 the game in the "Vertical separation" case, i.e. when two competing independent manufacturers invest. We then solve in Section 3.2 the game in the "Vertical integration" case, i.e. when both the independent manufacturer U_H and the integrated firm I invest. We then determine in Section 3.3 whether vertical integration is desirable for industry profit, welfare and firms and investigate in Section 3.4 some extensions.

[16]Note that this efficiency result would also hold under public contracts.

3.1 Vertical Separation Case

BARGAINING OUTCOME In Stage 2, manufacturers U_H and U_L bargain with retailer D:

$$\max_{T^H} \left(\Pi^{HL} - T^H - T^L - (\Pi^L - T^L)\right)^{1-\alpha} \left(T^H\right)^{\alpha}$$

$$\max_{T^L} \left(\Pi^{HL} - T^H - T^L - (\Pi^H - T^H)\right)^{1-\alpha} \left(T^L\right)^{\alpha}$$

where $\Pi^L - T^L$ and $\Pi^H - T^H$ are the respective status-quo profit of the retailer in the bilateral negotiations with U_H and U_L. We obtain the following fixed fees:

$$T^H = \alpha \left(\Pi^{HL} - \Pi^L\right),$$
$$T^L = \alpha \left(\Pi^{HL} - \Pi^H\right).$$

The negotiations lead to the following profits:

$$\pi^s_{U_H}(h,l) = \alpha(\Pi^{HL} - \Pi^L), \tag{1}$$

$$\pi^s_{U_L}(h,l) = \alpha(\Pi^{HL} - \Pi^H), \tag{2}$$

$$\pi^s_D(h,l) = \Pi^{HL} - T^H - T^L = \alpha(\Pi^L + \Pi^H) + (1-2\alpha)\Pi^{HL}, \tag{3}$$

where profits resulting from bilateral negotiations are denoted by $\pi^s_{U_Q}$ for U_Q and π^s_D for D. The subscript s stands for the "Vertical Separation case".

INVESTMENTS In Stage 1, the two manufacturers simultaneously choose their investment h and l maximizing respectively $\pi^s_{U_H} - c(h)$ and $\pi^s_{U_L} - c(l)$ where $\pi^s_{U_H}$ and $\pi^s_{U_L}$ are defined by equations (1) and (2). The first-order conditions are:

$$\alpha\left(\frac{\partial \Pi^{HL}}{\partial h} + \beta \frac{\partial \Pi^{HL}}{\partial l}\right) - c'(h) = 0, \tag{4}$$

$$\alpha \frac{\partial \Pi^{HL}}{\partial l} - c'(l) = 0. \tag{5}$$

A standard "*hold-up*" effect arises because U_H and U_L each only get a share α of the marginal benefit of their investment. This hold-up effect tends to limit manufacturer's investments. Note also that manufacturers cannot affect the sharing of their profit with the retailer through their investment. Indeed, the investment on their own product does not affect the status-quo profit of the retailer in their bilateral bargaining. When $\beta > 0$, a spillover effect also appears for U_H. Indeed, U_H internalizes the positive externality of its own investment on that of its rival U_L which increases its incentive to invest.

Equations (4) and (5) define the best reaction functions in investments of each manufacturer denoted $h = R_{U_H}(l)$ and $l = R_{U_L}(h)$. We totally differentiate (4) and (5) and obtain:

$$R'_{U_H}(l) = -\frac{\alpha(\frac{\partial^2\Pi^{HL}}{\partial h\partial l} + \beta\frac{\partial^2\Pi^{HL}}{\partial l^2})}{\varphi}, \text{where } \varphi \equiv \alpha(\frac{\partial^2\Pi^{HL}}{\partial h^2} + 2\beta\frac{\partial^2\Pi^{HL}}{\partial l\partial h} + \beta^2\frac{\partial^2\Pi^{HL}}{\partial l^2}) - c''(h), \quad (6)$$

$$R'_{U_L}(h) = -\frac{\alpha(\frac{\partial^2\Pi^{HL}}{\partial l\partial h} + \beta\frac{\partial^2\Pi^{HL}}{\partial l^2})}{\mu}, \text{ where } \mu \equiv \alpha\frac{\partial^2\Pi^{HL}}{\partial l^2} - c''(l). \quad (7)$$

We define the following threshold $\tilde{\beta}$, where:

$$\tilde{\beta} \equiv \frac{|\frac{\partial^2\Pi^{HL}}{\partial h\partial l}|}{\frac{\partial^2\Pi^{HL}}{\partial l^2}},$$

where $\tilde{\beta} < 1$ under Assumption A.5.[17] In what follows, we develop our analysis considering alternatively the case in which $\beta \in [0, \tilde{\beta})$ and $\beta \in (\tilde{\beta}, 1]$. When $\beta \in [0, \tilde{\beta})$, $R'_{U_L}(h)$ and $R'_{U_H}(l)$ are negative and investments are strategic substitutes. In contrast, when $\beta \in (\tilde{\beta}, 1]$, $R'_{U_L}(h)$ and $R'_{U_H}(l)$ are positive and investments are strategic complements.

Lemma 1. *When $0 \leq \beta < \tilde{\beta}$, an increase in the investment of U_H (resp. U_L) decreases in turn the investment of U_L (resp. U_H). When $\tilde{\beta} < \beta$, an increase in the investment of U_H (resp. U_L) increases in turn the investment of U_L (resp. U_H).*

Proof. Assumptions A.4 and A. 5 imply that each manufacturer's net profit function is concave in its own investment, i.e. $\varphi < 0$ and $\mu < 0$. As a consequence, both reaction functions are decreasing, that is $R'_{U_H}(l) < 0$ and $R'_{U_L}(h) < 0$ when $0 \leq \beta < \tilde{\beta}$ and increasing when $\tilde{\beta} < \beta$. □

Note that, as shown in equations (6) and (7), when $0 \leq \beta < \tilde{\beta}$, that is under low spillovers, the strategic substitution among manufacturers' investments reflects here a "*free-riding effect*". In our set-up the presence of the downstream monopolist internalizes all competitive externalities among products. Therefore, both manufacturers

[17] Note that the determinant of the hessian matrix of Π^O is positive under Assumption A.5 which implies that $|\frac{\partial^2\Pi^{HL}}{\partial h\partial l}| < \frac{\partial^2\Pi^{HL}}{\partial l^2} - c''(l) < \frac{\partial^2\Pi^{HL}}{\partial l^2}$ and thus that $\tilde{\beta} < 1$.

have a common objective to maximize the industry profit Π^{HL}. Each manufacturer thus prefers to rely on rival's investment which tends to limit its own investment; this free-riding effect explains the strategic substitutability among investments in our analysis. However, when $\tilde{\beta} < \beta$, that is under high spillovers, investments become strategic complements. It generates a positive "*spillover effect*" that encourages U_H to invest offsetting this negative free-riding effect.

We obtain the following lemma:

Lemma 2. *Equations (4) and (5) uniquely define a couple of equilibrium investments* (h^s, l^s).

Proof. Under A.5 each manufacturer's profit is concave in its own investment decision which guarantees that reaction functions *cross once* and that $-1 < R'_{U_H}(l) < 0$ and $-1 < R'_{U_L}(h) < 0$ when $0 \leq \beta < \tilde{\beta}$ and that $0 < R'_{U_H}(l) < 1$ and $0 < R'_{U_L}(h) < 1$ when $\tilde{\beta} < \beta$ which guarantees the equilibrium existence. See Appendix B for a detailed proof. □

3.2 Vertical Integration Case

Bargaining Outcome D is now integrated backward with U_L to form a new entity denoted I. Hence, only manufacturer U_H bargains with the integrated firm I:

$$\max_{T^H} \left(\Pi^{HL} - T^H - \Pi^L\right)^{1-\alpha} \left(T^H\right)^{\alpha}$$

where Π^L is the status-quo profit of the retailer in the bilateral negotiation with U_H. We obtain the following fixed fee:

$$T^H = \alpha \left(\Pi^{HL} - \Pi^L\right).$$

The negotiation leads to the following profit:

$$\pi^i_{U_H}(h,l) = \pi^s_{U_H}(h,l) = \alpha(\Pi^{HL} - \Pi^L), \tag{8}$$

$$\pi^i_I(h,l) = \Pi^L + (1-\alpha)(\Pi^{HL} - \Pi^L), \tag{9}$$

where profits resulting from bilateral negotiation are denoted by $\pi^i_{U_H}$ for U_H and π^i_I for I. The subscript i stands for "Vertical Integration case".

Before analysing investment decisions, a first comparison between (2) and (9) leads to the following lemma:

Lemma 3. *The vertically integrated retailer I always has a stronger incentive to invest than the independent manufacturer U_L regardless of α.*

Proof. Straightforward as, under Assumption A.2, $\frac{\partial \Pi^L}{\partial l} > \frac{\partial \Pi^{HL}}{\partial l}$. □

This entirely derives from the fact that the integrated I fully internalizes the benefit of its investment on its status-quo profit Π^L. The following subsection further explores the consequences on U_H incentives to invest and the change in equilibrium investments when facing the vertically integrated I instead of an independent manufacturer U_L.

INVESTMENTS In Stage 1, U_H and I simultaneously choose their investment h and l maximizing respectively $\pi^i_{U_H} - c(h)$ and $\pi^i_I - c(l)$ with $\pi^i_{U_H}$ and π^i_I defined by (8) and (9). As $\pi^i_{U_H} = \pi^s_{U_H}$, the investment decision of U_H is given by (4). The investment decision of I is given by the following first-order condition:

$$\alpha \frac{\partial \Pi^L}{\partial l} + (1-\alpha)\frac{\partial \Pi^{HL}}{\partial l} - c'(l) = 0. \tag{10}$$

Equations (4) and (10) define the best reactions functions in investments of each firm denoted $h = R_{U_H}(l)$ previously defined by (4) and $l = R_I(h)$. We totally differentiate (10) and obtain:

$$R'_I(h) = -\frac{(1-\alpha)(\frac{\partial^2 \Pi^{HL}}{\partial l \partial h} + \beta \frac{\partial^2 \Pi^{HL}}{\partial l^2})}{\kappa}, \text{where } \kappa \equiv \alpha \frac{\partial^2 \Pi^L}{\partial l^2} + (1-\alpha)\frac{\partial^2 \Pi^{HL}}{\partial l^2} - c''(l). \tag{11}$$

Lemma 4. *When $0 \le \beta < \tilde{\beta}$, an increase in the investment of I (resp. U_H) decreases in turn the investment of U_H (resp. I). When $\tilde{\beta} < \beta$, an increase in the investment of I (resp. U_H) increases in turn the investment of U_H (resp. I).*

Proof. Assumptions A.4 $\frac{\partial^2 \Pi^{HL}}{\partial l \partial h} < 0$ and A. 5 imply that I's net profit function is concave in its own investment, i.e. $\kappa < 0$. As a consequence, when $0 \le \beta < \tilde{\beta}$, $I's$ reaction function is decreasing, that is $R'_I(h) < 0$ whereas when $\tilde{\beta} < \beta$, $R'_I(h) > 0$. □

Comparing (10) with (5) enables to compare the vertically integrated I's investment decision with that of an independent manufacturer U_L. As in the vertical separation case, both a free-riding and a hold-up effect arise. However, the vertically integrated I can now directly affect its status-quo in the bargaining with U_H, and thus the sharing of industry profit, through its investment. As a result, I chooses its investment to maximise a weighted average of the industry profit and its status-quo profit. This status-quo effect implies that I has a strictly larger incentive to invest than U_L as already shown in Lemma 3. Equations (6) and (11) show that, when $0 \leq \beta < \tilde{\beta}$, the free-riding effect resulting from the strategic substitution among firms' investments outweigh the spillover effect and therefore best reaction functions are decreasing. When $\tilde{\beta} < \beta$, the spillover effect prevails over the free-riding effect and best reaction functions are increasing.

Lemma 5. *Equations (4) and (10) uniquely define a couple of equilibrium investments* (h^i, l^i).

Proof. Under A.5 each firm's profit is concave in its own investment decision which guarantees that reaction functions *cross once* and that $-1 < R'_{U_H}(l) < 0$ and $-1 < R'_I(h) < 0$ when $0 \leq \beta < \tilde{\beta}$ and that $0 < R'_{U_H}(l) < 1$ and $0 < R'_I(h) < 1$ when $0 \leq \beta < \tilde{\beta}$ which guarantees the equilibrium existence. See Appendix B for a detailed proof. □

Figure 1 depicts U_H, U_L and I's reaction functions and equilibrium investments under the two market structures using the linear demand model of Shubik and Levitan (1980). The qualities of products H and L are the sum of a baseline quality level $q_0 = h_0, l_0$ and an investment $q = h, l$. We denote d_H and d_L the quantities of each product. The representative consumer's utility for products H, L thus writes as follows:

$$\nu + U_{HL} = \nu + (h + h_0)d_H + (l + l_0)d_L - \frac{1}{2}(d_H^2 + d_L^2) - \gamma d_H d_L.$$

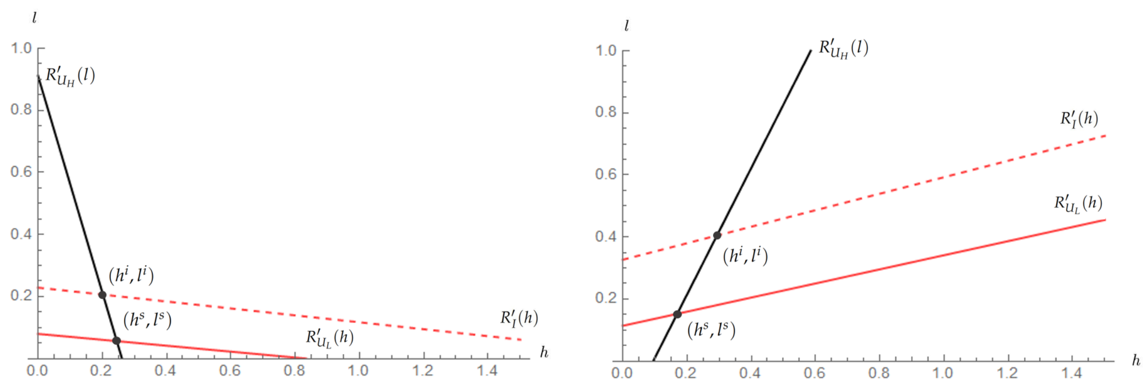
where the parameter ν is a numeraire ($p_\nu = 1$), γ is the degree of substitutability between products H and L and d_H and d_L are the quantities of each product. This illustration depends on the parameter γ of substitution between H and L and the baseline quality levels of these products, respectively h_0 and l_0.[18] Figure 1.1 shows the decreasing reaction functions under low spillovers and Figure 1.2 the increasing reaction functions under high spillovers. In Figure 1.1, i.e. the case with low spillover, as compared to the best reaction of U_L, I's reaction function shifts upward. In contrast, the best reaction function of U_H is unchanged. As a consequence, I invests more than U_L and U_H invests

[18] See Appendix C for more details.

less in the vertical integration case: a hold-up effect is increased for U_H through the larger investment of I. In Figure 1.2, i.e. the case with high spillover, I's reaction function also shifts upward implying that I invests more than U_L. Under high spillovers, U_H also invests more in the vertical integration case. We thus obtain the following proposition:

Proposition 1. *Regardless of α, a vertically integrated retailer always invests more than a rival manufacturer. In turn, vertical integration always discourages (resp. encourages) the independent manufacturer's investment with low (resp. high) spillovers.*

Figure 1. Reaction functions



1.1. Low spillovers ($\beta = 0$) 1.2. High spillovers ($\beta = 0.6$)

Note: Figures are drawn from the linear demand described in Appendix C with parameter values $\gamma = 0.3$, $h_0 = 0.5$, $l_0 = 0.25$ and $\alpha = 0.5$. Cost functions are $c(h) = h^2$ and $c(l) = l^2$.

Overall, the presence of strong spillovers has a positive effect on innovation in a simultaneous investment game.

3.3 Industry Profit, Welfare and Incentive for Vertical Integration

In this section, we first analyse whether it is profitable for total industry profit and welfare to have the integrated retailer that invests rather than a rival manufacturer. We then investigate the profitability for I to vertically integrate.

Industry Profit and Welfare The investments maximizing the vertically integrated industry profit are:

$$h^O(l) \quad \text{defined by} \quad \frac{\partial \Pi^O(h, l+\beta h)}{\partial h} = 0 \Leftrightarrow \frac{\partial \Pi^{HL}}{\partial h} + \beta \frac{\partial \Pi^{HL}}{\partial l} - c'(h) = 0, \qquad (12)$$

$$l^O(h) \text{ defined by } \frac{\partial \Pi^O(h, l+\beta h)}{\partial l} = 0 \Leftrightarrow \frac{\partial \Pi^{HL}}{\partial l} - c'(l) = 0. \tag{13}$$

Lemma 6. *Equations (12) and (13) uniquely define a couple of optimal equilibrium investments denoted* (h^O, l^O).

The investment maximizing the industry profit when only product L is sold is:

$$\bar{l}^O \text{ defined by } \frac{\partial \bar{\Pi}^O}{\partial l} = 0 \Leftrightarrow \frac{\partial \Pi^L}{\partial l} - c'(l) = 0. \tag{14}$$

Note that, under Assumption A.2, we have $\bar{l}^O > l^O(0) > l^O$. We now compare the investment levels found in the vertical separation case, i.e. (h^s, l^s), and the vertical integration case, i.e. (h^i, l^i), with the level of investment (h^O, l^O) maximizing the industry profit. We obtain the following proposition:

Proposition 2. *Vertical integration is desirable (resp. undesirable) for the industry whenever the buyer power is large (resp. low). In the linear demand case, there exists a unique threshold* α_1 *(resp.* $\alpha_2 > \alpha_1$*) below which vertical integration is desirable for the industry with low (resp. high) spillovers.*

Proof. We must compare (h^s, l^s) with the equilibrium investments (h^i, l^i). When α tends to 1, the optimal investments are realized in the vertical separation case and the corresponding industry profit is $\Pi^O(h^O, l^O)$. In contrast, in the vertical integration case the two investments are distorted as compared to their optimal levels: The investment levels are $l^i = \bar{l}^O > l^O$ which means that I always over invests, regardless of whether spillovers are low or high. When $0 \leq \beta < \tilde{\beta}$, $h^i = h^O(\bar{l}^O) < h^O$ which means that U_H under invests with low spillovers. When $\tilde{\beta} < \beta$, we have $h^i = h^O(\bar{l}^O) > h^O$ which means that U_H over invests with high spillovers. It is thus straightforward that $\Pi^O(h^O, l^O) > \Pi^O(h^i, l^i)$ because investments are always distorted as compared to the optimum in the vertical integration case. When α tends to 0, in the vertical separation case, the manufacturers never invest and the corresponding industry profit is $\Pi^O(0, 0)$. In contrast, in the vertical integration case, I chooses the investment that maximizes the industry profit given that U_H does not invest $l^i(0) = l^O(0)$. Therefore $\Pi^O(0, 0) < \Pi^O(0, l^O(0))$ and it is always desirable that I invests in $\alpha = 0$ and by continuity when α is low. □

The insight for the above proposition is as follows. Whenever the buyer power is low, the hold-up effect is limited under vertical separation and therefore the investments of the manufacturers are close to the optimum industry level. In contrast, the retailer over invests under vertical integration which distorts either downward or upward the investment of the independent manufacturer. However, when the buyer power is large, there is a strong hold-up problem which leads the manufacturers to invest below their optimal industry level. Vertical integration however solves this hold-up problem which benefits the industry even when the independent manufacturer is in reaction discouraged from investing.

We now compare the level of welfare in the two market structures. As in Spence (1975), we only compare here the level of investment privately chosen by the firms with the level of investments that maximize social welfare.[19]

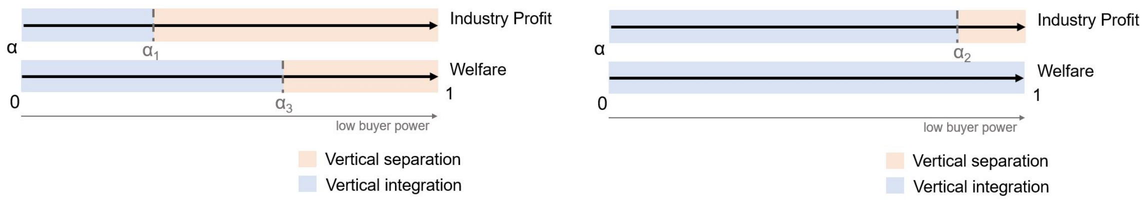
When $\alpha = 0$ only I invests and therefore both total industry profit and welfare improve when I invests rather than U_L. When $\alpha = 1$ the comparison for welfare between the two market structures is unclear: on the one hand, it is desirable for the industry to have U_L that invests, but on the other hand, if the integrated I invests, its over investment benefits consumers. Using our linear demand illustration, we find that:

Proposition 3. *With a linear demand, vertical integration is welfare improving whenever $\alpha < \alpha_3$ (with $\alpha_3 > \alpha_1$) when spillovers are low and for all α when spillovers are high.*

Figure 2.1 and 2.2 summarize the desirability of market structures for industry profit and welfare as a function of α when spillovers are low or high, respectively. In Figure 2.1, we denote α_3 the threshold above which it is profitable for welfare to have U_L that invests when spillovers are low. In contrast, in Figure 2.2, we see that it is always optimal for welfare to have I investing when spillovers are high. Moreover, when $\alpha_3 > \alpha > \alpha_1$, it may be optimal for welfare to have I investing when it is better for industry profit to have U_L investing. This is due to I's over investment which benefits consumers while it hurts industry profit. Similar reasoning applies under the presence of spillover whenever $\alpha > \alpha_2$ (i.e. Figure 2.2). Finally, note that vertical integration becomes welfare enhancing for a broader range of α when the initial quality gap is decreasing. Indeed, under vertical integration, for l_0 large, I's higher investment relates to a relatively high quality brand which is more likely to outweigh the lower investment of U_H and therefore benefits consumers.

[19] Note that prices are set at their monopoly level in the two cases; as in Spence (1975), we do not set prices at the competitive level when computing social welfare.

Figure 2. Industry Profit and Welfare



2.1. Low spillovers ($\beta = 0$) 2.2. High spillovers ($\beta = 0.6$)

Note: Figures are drawn from the linear demand described in Appendix C with parameter values $\gamma = 0.3$, $h_0 = 0.5$, $l_0 = 0.25$ and $\alpha = 0.5$. Cost functions are $c(h) = h^2$ and $c(l) = l^2$. The thresholds are: $\alpha_1 = 0.33$, $\alpha_2 = 0.78$ and $\alpha_3 = 0.63$.

Our main finding is that in presence of a large buyer power, it is desirable to have the retailer investing rather than a rival manufacturer. Overall this results tend to illustrate the actual trend in the evolution in CPG's innovation. In the last decades we have observed both an increasing buying power in the retail industry, an important rise in the private label market share, and increasingly innovative private labels. Our model somehow rationalizes this observed pattern and tends to highlight its potential benefit for industry and consumers. We highlight in Section 3.4, however, that vertical integration may lead to an average decrease in the quality of products sold to consumer.

Incentive for Vertical Integration Formally, vertical integration is profitable if D and U_L's joint profits (including the investment costs) are higher under integration than under separation. The joint profit of U_L and D's is:

$$\pi_I^i(h,l) - c(l) = \alpha\Pi^L + (1-\alpha)\Pi^{HL} - c(l).$$

Hence, the difference in investments between the vertical separation and the vertical integration cases fully determines the profitability of vertical integration. The condition such that vertical integration is profitable therefore is $\pi_I^i(h^i,l^i) - c(l^i) > \pi_I^i(h^s,l^s) - c(l^s)$. More generally, two effects play in opposite direction: on the one hand, when integrated, for a given level of investment h^s, I takes the optimal decision on the investment $l^i(h^s)$ for the integrated structure whereas when U_L invests, it only takes into account its marginal revenue of investment and therefore invests $l^s(h^s)$. This translates into $\pi_D^i(h^s,l^i(h^s)) - c(l^i) > \pi_D^i(h^s,l^s(h^s)) - c(l^s)$ which tends to make vertical integration profitable. This effect is the same when spillovers are either low or high. Moreover, under high spillovers, U_H also invests more under vertical integration $h^i > h^s$

which tends to make vertical integration even more profitable. In contrast, under low spillovers, U_H chooses a lower investment level under vertical integration $h^i < h^s$ which tends to make vertical integration unprofitable.

Balancing the two effects for all α is not obvious, but we are able to show in our linear demand example that vertical integration is always profitable. In the linear case, we thus highlight that private incentives to vertically integrate are too high as compared to what would be desirable for the industry whether spillovers are low or high.[20] As D always vertically integrates and innovates, this may also be detrimental for welfare with low spillovers.

3.4 Discussion

In this section, we discuss our results along several dimensions. We first study the effect of the baseline quality gap on the average quality level of products offered to consumers. We then discuss the robustness of our results to linear wholesale contracts and to the existence of investment cost asymmetry between the retailer and manufacturers.

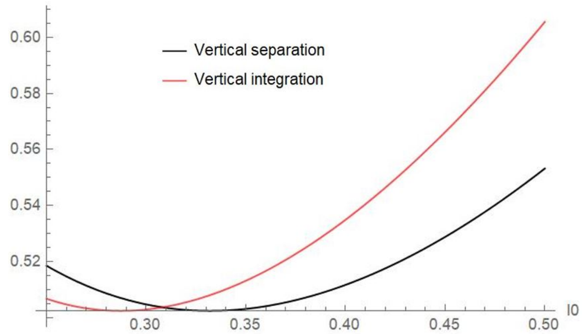
VERTICAL INTEGRATION AND AVERAGE QUALITY In this extension, we define the average quality $\bar{v} = \frac{l \times ql}{(qh+ql)} + \frac{h \times qh}{(qh+ql)} = \bar{l} + \bar{h}$ and analyze its variation under the two market structures. To do so, we focus on the linear demand case; we set the level of $h_0 = 0.5$ and allow l_0 to vary in the interval $[0.25, 0.5]$. We focus our discussion on the case in which spillovers are low where the effects of vertical integration on the average quality are contrasted.

We find that, as shown in Figure 3.1, the average quality of products sold may be lower under vertical integration whenever the initial quality gap is large. This reflects that, even if the overall level of investments always increases, vertical integration may lead to an average decrease in the quality of products sold to consumers.

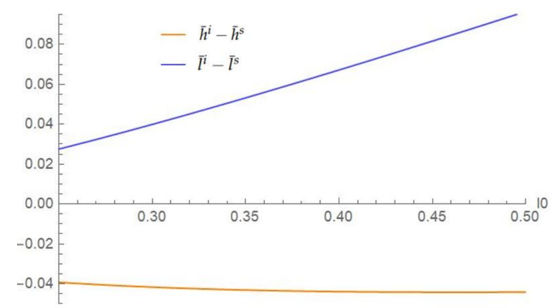
Figure 3.2 shows that the contribution of product H to the average quality is always lower under vertical integration (i.e. $\bar{h}^i < \bar{h}^s$) whereas that of product L sold is always higher (i.e. $\bar{l}^i > \bar{l}^s$). For l_0 small, even though I invests more on its brand as compared to U_L, this investment relates to a low quality good and therefore it is not sufficient to compensate the decrease in U_H's investment which relates to the highest quality good. Vertical integration in that case leads to an overall decrease in average quality.

[20] Note that whenever the joint industry profit decreases where U_L and D's joint profit increase, U_H's profit must decrease.

Figure 3. Effect of Baseline Quality Gap on the Average Quality



3.1. Average quality level



3.2. Difference in contribution to the average quality

Note: Figures are drawn from the linear demand described in Appendix C with parameter values $\gamma = 0.3$, $h_0 = 0.5$, $\beta = 0$ and $\alpha = 0.5$. Cost functions are $c(h) = h^2$ and $c(l) = l^2$.

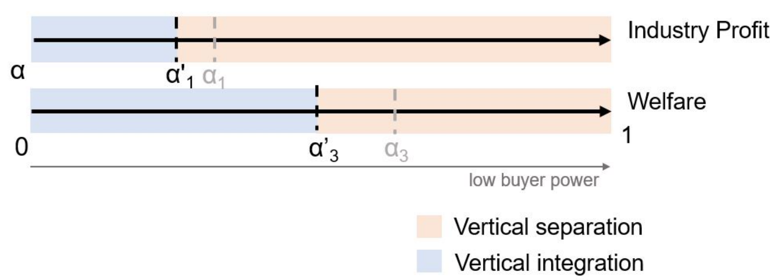
Or, put differently, the larger investment on private labels is not sufficient to compensate the lower investment on the national brands and the switch of consumers towards private labels lead to a decrease in the average quality of product purchased. Yet, for l_0 large, the contribution of product L between the two market structures is increasing and now outweighs the decrease generated on U_H investment. Note that when l_0 is sufficiently close to h_0 ($l_0 \approx 0.43$), there is a leapfrog effect as the "low" quality good becomes higher than the "high" quality good. It is immediate in that case that vertical integration, by pushing consumers towards high quality private labels, also increases the average quality of products purchased.

LINEAR TARIFF It is well known that, with linear tariff, vertical integration solves double marginalization and this effect adds up to the effect of hold-up previously highlighted. I always obtains a higher profit than U_L and thus invests more. Although it is difficult to get general results and derive conclusion in the linear demand case due to computational burden, it is likely that our main result along which vertical integration in turn would discourage (resp. spur) U_H to invest with low (resp. high) spillovers still holds. In contrast, given that vertical integration enables to solve at least partly the double marginalisation, i.e. inefficiency, it is likely that it will be more desirable for industry and welfare than when considering two-part tariffs.

COST DISADVANTAGE FOR THE RETAILER So far we have assumed that the retailer was as efficient in its innovation process as the two manufacturers U_L and U_H. Retailers' function was for a long time limited to the distribution of goods across many product categories and it is only recently that they took a larger role in the innovation of products. The conception of products, however, is far away from the retailer's core activities and is therefore likely to generate additional costs.[21] To reflect this view, we now assume that the retailer has a higher marginal investment cost than the two manufacturers, namely a marginal cost $C'(l) > c'(l)$, and study how it affects our results.

First it is straightforward that the equilibrium is unchanged in the vertical separation case. We consider the vertical integration case in which U_H and I compete to innovate. Due to higher marginal investment cost, I invests less. As the increase in I's marginal cost of investment reduces the industry profit, the threshold in α below which it is desirable for industry profit and welfare to have I that innovates is lowered. We illustrate this result in the linear demand case on the following Figure 4 that represents the new thresholds α_1' and α_3' with $\alpha_1' < \alpha_1$ and $\alpha_3' < \alpha_3$ with low spillovers. Similar results arise whith high spillovers.

Figure 4. Industry Profit and Welfare



Note: This figure is drawn from the linear demand described in Appendix C with parameter values $\gamma = 0.3$, $h_0 = 0.5$, $l_0 = 0.25$ and $\beta = 0$. Cost functions are $c(h) = h^2$ and $C(l) = \frac{3}{2}l^2$. The thresholds are: $\alpha_1' = 0.27$ and $\alpha_3' = 0.49$.

4 Extension with a Leader Manufacturer

From a competition policy perspective, we have shown that, in a scenario of simultaneous timing, when the risk of imitation is high (indicating strong spillover effects), the

[21] Even if the retailer integrates backward with a manufacturer, moral hazard issues may arise generating extra cost of innovation.

independent manufacturer invests more under vertical integration. However, simultaneous timing implies that the independent manufacturer does not internalize its effect on the rival's investment and therefore may not be the most natural when thinking of imitation. In this section, we extend our analysis by enabling U_H to take into account the positive spillover it creates through its investments on its rival and thus potential discouragement or encouragement effects on its investment. We do so by assuming a sequential timing in which the leader chooses the level of its investment before U_L in the vertical separation case or before I in the vertical integration case. Note that, in contrast with some analysis that assume that vertical integration in itself may create a risk of imitation, such as Milliou (2004), we instead assume that this risk is not specific to vertical integration. A vertically separated U_L might as well imitate as an integrated I.[22] Given that investment decisions are sequential, we modify the first stage of the game leaving the second stage bargaining unchanged. The Stage 1 is now as follows: in Stage 1.1, U_H invests and in Stage 1.2, either U_L invests in the vertical separation case or I invests in the vertical integration case.

4.1 Vertical Separation Case

Solving this investment stage backward, U_L chooses $l = R_{U_L}(h)$ and U_H chooses its investment maximizing $\pi^s_{U_H}(h, R_{U_L}(h)) - c(h)$. The first order condition of U_H is as follows:

$$\alpha\left(\frac{\partial \Pi^{HL}}{\partial h} + \beta \frac{\partial \Pi^{HL}}{\partial l} + \left(\frac{\partial \Pi^{HL}}{\partial l} - \frac{\partial \Pi^{L}}{\partial l}\right) R'_{U_L}(h)\right) - c'(h) = 0. \tag{15}$$

As in the simultaneous vertical separation case, a hold-up and a spillover effects still arise. In contrast, a status-quo effect appears.

Lemma 7. *Equations (5), (7) and (15) uniquely define a couple of investments (h^s_1, l^s_2) where the subscript refers to the timing of investment decisions. In a sequential game, the leader always invests more and the follower invests less than in a simultaneous game, i.e. $h^s_1 > h^s$ and $l^s_2 < l^s$ with low spillovers. With high spillovers, the leader and the follower always invest less than in a simultaneous game, i.e. $h^s_1 < h^s$ and $l^s_2 < l^s$.*

[22] This is realistic in the particular case of the food industry where innovations are incremental and where any firm may reverse engineer a given product recipe at a relatively low cost to develop its own copy.

In this sequential investment game, given that U_H takes its investment decision first, it internalizes the effect of its own investment on that of U_L. According to Lemma 1, when spillovers are low, the lower U_H's investment the larger U_L invests in turn. Therefore, U_H has an incentive to restrict its investment to push U_L to invest more which illustrates a free-riding effect. However, a status-quo effect counteracts this free-riding effect. Indeed, a larger investment by U_H decreases in turn U_L's investment and, as a consequence, the status-quo profit of the retailer in its bargaining with U_H. This indirect status-quo effect thus pushes U_H to invest more. Overall, U_H, by incorporating U_L's best response in its profit-maximizing function, invests more than in a simultaneous game ($h_1^s > h^s$) when spillovers are low. U_L reacts accordingly and chooses a lower investment ($l_2^s < l^s$). This result corresponds to the classic Stackelberg equilibrium under strategic substitution in which the leader is in a position to obtain more profit by limiting its rival's action.

When spillovers are high, the reasoning is fully reversed. U_H has an incentive to reduce its investment. Therefore, U_H internalizes that raising its own investment increases the rival's investment and in turn the status-quo profit of the retailer. As a consequence, U_H invests less than in a simultaneous game ($h_1^s < h^s$) and U_L chooses a lower investment ($l_2^s < l^s$).

4.2 Vertical Integration Case

Solving the investment game backward, I chooses $l = R_I(h)$ and U_H chooses its investment maximizing $\pi^s_{U_H}(h, R_I(h)) - c(h)$. The first order condition is as follows:

$$\alpha\left(\frac{\partial \Pi^{HL}}{\partial h} + \beta\frac{\partial \Pi^{HL}}{\partial l} + \left(\frac{\partial \Pi^{HL}}{\partial l} - \frac{\partial \Pi^{L}}{\partial l}\right)R_I'(h)\right) - c'(h) = 0. \tag{16}$$

Again a hold-up, a spillover and a status-quo effects arise and the mechanism at play is similar to that described in the vertical separation case. The intersection of best reaction functions leads to the following lemma:

Lemma 8. *Equations (10), (11) and (16) uniquely define a couple of investments (h_1^i, l_2^i) where the subscript refers to the ranking in investment decision. In a sequential game, the leader always invests more and the follower invests less than in a simultaneous game, i.e. $h_1^i > h^i$ and $l_2^i < l^i$ with low spillovers. Whith high spillovers, the leader and the follower always invest less than in a simultaneous game, i.e. $h_1^i < h^i$ and $l_2^i < l^i$.*

Comparing the slope of the reaction of I with the slope of the reaction of U_L following an increase in U_H's investment leads to the following lemma:

Lemma 9. *When U_H is a leading manufacturer, an increase in its investment triggers a larger (resp. smaller) response in the vertically integrated I's investment rather than in the independent manufacturer U_L's investment when the buyer power is high (resp. small).*

Proof. The sign of the difference $|R'_{U_L}(h)| - |R'_I(h)|$ is given by $sign\left[(2\alpha - 1)c''(l) - \alpha^2 \frac{\partial^2 \Pi^L}{\partial l^2}\right]$,

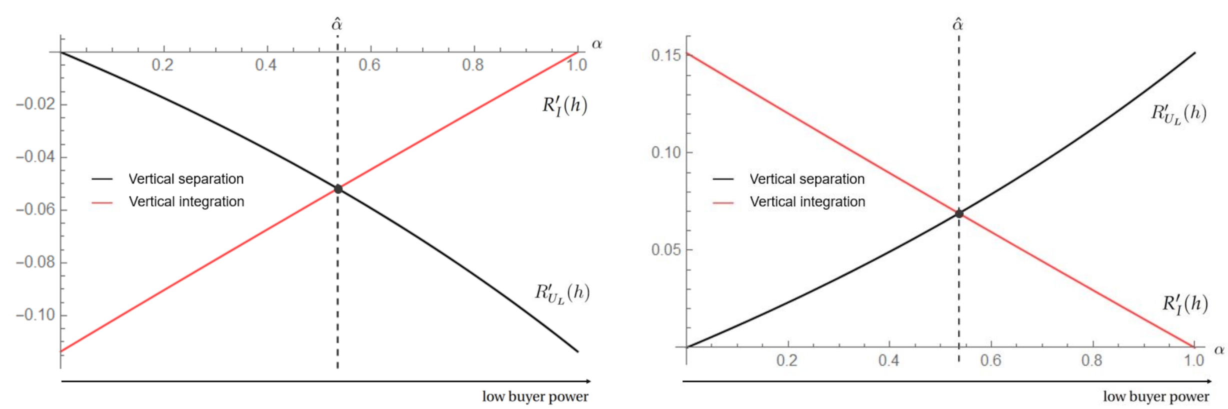
- For $\alpha = 0$, $sign[-c''(l)] < 0$, $|R'_{U_L}(h)| < |R'_I(h)|$,

- For $\alpha = \frac{1}{2}$, $sign\left[-\frac{1}{4}\frac{\partial^2 \Pi^L}{\partial l^2}\right] < 0$, $|R'_{U_L}(h)| < |R'_I(h)|$,

- For $\alpha = 1$, $sign\left[c''(l) - \frac{\partial^2 \Pi^L}{\partial l^2}\right] > 0$, $|R'_{U_L}(h)| > |R'_I(h)|$

(see Appendix D for a complete proof). □

Figure 5. Slope of U_L and I reaction functions



5.1. Low spillovers ($\beta = 0$)

5.2. High spillovers ($\beta = 0.6$)

Note: Figures are drawn from the linear demand described in Appendix C with parameter values $\gamma = 0.3$, $h_0 = 0.5$ and $l_0 = 0.25$. Cost functions are $c(h) = h^2$ and $c(l) = l^2$.

The insight of Figure 5 is as follows. When α is small (i.e. high buyer power), the marginal return of I's investment is high because it obtains a large part of the industry profit. Hence, when U_H increases its investment, it triggers a larger decrease (resp.

increase) in I's investment than in U_L's investment with low (resp. high) spillovers. In contrast, when α is high, the marginal return of I's investment over the pie Π^{HL} is lower than that of U_L, and therefore I decreases (resp. increases) less its own investment following an increase in U_H's investment with low (resp. high) spillovers. We see in both Figure 5.1 and Figure 5.2 that the slopes of I and U_L's best response vary with α in opposite directions. The intersection between the two lines represents the threshold $\hat{\alpha}$ such that for all α below $\hat{\alpha}$ U_H invests to a larger (resp. smaller) extent under vertical integration as compared to vertical separation with low (resp. high) spillovers.[23] We obtain the following proposition:

Proposition 4. *In the presence of a leading manufacturer, the vertically integrated I always invests more than a rival independent manufacturer. In turn, when buyer power is high, vertical integration spurs (resp. stifles) the leading manufacturer's investment with low (resp. high) spillovers. When the buyer power is low, vertical integration stifles (resp. spurs) the leading manufacturer's investments with low (resp. high) spillovers.*

Note first that I always invests more than U_L in presence of a leading manufacturer as in a simultaneous game. Second, regarding U_H's investment, results of Proposition 4 are similar to those of Proposition 1 in presence of a leading manufacturer whenever the buyer power is low enough. Interestingly, when the buyer power is large, the results of Proposition 1 are reversed as U_H now invests more when spillovers are low and less when spillovers are high.[24]

Table 1. Vertical Integration on Innovation with a Leading Manufacturer

h , l	Low spillovers $0 \leq \beta < \tilde{\beta}$	High spillovers $\tilde{\beta} < \beta$
Low buyer power	$-,+$	$+,+$
High buyer power	$+,+$	$-,+$

Note: "+" = increasing; "-" = decreasing; with respect to the vertical separation case.

[23]The presence of status-quo into I's best response implies that $\hat{\alpha}$ is above 0.5 (i.e equal bargaining power). Since I has a higher incentive to invest than U_L all others thing being equal, U_H still invests more (resp. less) under vertical integration even when its bargaining power becomes higher than the one of the integrated I with low (resp. high) spillovers.

[24]We show in Appendix E that our results of Proposition 2 and 3 also hold in the presence of a leading manufacturer.

As described in Table 1, when the leader internalizes the effect of its investment on the rival, results differ according to the level of bargaining power and spillovers. In presence of a risk of imitation (high spillover), vertical integration discourages the independent manufacturer from investing when the buyer power is high. Therefore, European regulators should closely scrutinize vertical integration by a powerful retailer if a strong imitation concern arises.

5 Conclusion

This article shows that, in contrast with existing literature, vertical integration does not systematically deter an independent manufacturer from investing. From a competition policy perspective, we find however that vertical integration discourages the independent manufacturer from investing under three scenarios. The first scenario arises in the simultaneous investment case. When spillovers are low, the independent manufacturer is discouraged to invest as a result of the larger incentives to invest of the integrated retailer (as compared to a rival manufacturer). The two other scenarios occur when the leader internalizes the effect of its investment on the rival (i.e., the sequential investment scenario). When spillovers are low, vertical integration pushes the manufacturer to reduce its investment when the buyer power is low. Finally, it can also be explained in the presence of buyer power and a high risk of imitation (high spillover) where in that case the manufacturer refrains from investing to limit the investment and imitation of the integrated retailer. Overall, under these three scenarios, we point out that vertical integration is likely to have a detrimental impact on welfare. This occurs when the negative consequences stemming from the decrease in the independent manufacturer's investment outweigh the benefits emerging from the larger incentive to invest of the integrated retailer. This situation arises when, regardless of the timing, both the risk of imitation and the buyer power are low. Furthermore, we also highlight that the integrated retailer always has an incentive to vertically integrate, even when it is detrimental for industry and welfare.

Applying our results to the retail market, in the last decades we have observed an important rise in the private label market share, and increasingly innovative private labels. Overall our results tend to illustrate that this trend in the evolution in CPG's innovation may potentially benefit consumers and the industry in the context of powerful retailers. Still, considering that retailers are less efficient in their investment process reduces the desirability of the outcome with an innovative retailer. The issues raised in this article may apply more broadly to online marketplaces (see Hagiu et al. (2022)). We plan in further research to analyze how our results extend when taking into account the peculiarities of online platform as opposed to physical retailer.[25]

Appendix

A Primitive Profit Functions

When a single product Q is sold on the market, the demand is $D_Q(p_Q, q)$, with $\partial_{p_Q} D_Q < 0$ and $\partial_q D_Q > 0$, where q refers to the investment on product Q, and p_Q to its price. When both products are sold the demand for each product Q is denoted $D_Q^{HL}(\mathbf{p}, \mathbf{q})$, with $\partial_{p_Q} D_Q^{HL}(\mathbf{p}, \mathbf{q}) < 0$, $\partial_{p_{-Q}} D_Q^{HL}(\mathbf{p}, \mathbf{q}) > 0$ and $\partial_q D_Q^{HL}(\mathbf{p}, \mathbf{q}) > 0$, where $\mathbf{p}$ and $\mathbf{q}$ respectively denote the vector of prices and investments.
In both cases demands are continuously differentiable and strictly concave in price(s) which ensure that there exist a unique optimum in price(s).
For a given level of investment q, we thus define the industry profit when only product Q is sold as:

$$\Pi^Q \equiv \max_{\{p_Q\}} p_Q D_Q(p_Q, q),$$

Similarly, we define the industry profit when the two products are sold as:

$$\Pi^{HL} \equiv \max_{\{p_H, p_L\}} p_H D_H^{HL}(\mathbf{p}, \mathbf{q}) + p_L D_L^{HL}(\mathbf{p}, \mathbf{q}).$$

B Concavity of firms' profit functions

Concavity of $\bar{\Pi}^O$ implies that $\frac{\partial^2 \bar{\Pi}^O}{\partial q^2} < 0$. Concavity of $\Pi^O(h, l + \beta h)$ implies that the matrix of second order derivatives is semi definite negative. The Hessian matrix is as follows:

$$\begin{vmatrix} \frac{\partial^2 \Pi^O(h,l+\beta h)}{\partial h^2} = \frac{\partial^2 \Pi^{HL}}{\partial h^2} + 2\beta \frac{\partial^2 \Pi^{HL}}{\partial l \partial h} + \beta^2 \frac{\partial^2 \Pi^{HL}}{\partial l^2} - c''(h) & \frac{\partial^2 \Pi^O(h,l+\beta h)}{\partial h \partial l} = \frac{\partial \Pi^{HL}}{\partial h \partial l} + \beta \frac{\partial^2 \Pi^{HL}}{\partial l^2} \\ \frac{\partial^2 \Pi^O(h,l+\beta h)}{\partial h \partial l} = \frac{\partial \Pi^{HL}}{\partial h \partial l} + \beta \frac{\partial^2 \Pi^{HL}}{\partial l^2} & \frac{\partial^2 \Pi^O(h,l+\beta h)}{\partial l^2} = \frac{\partial \Pi^{HL}}{\partial l^2} - c''(l) \end{vmatrix}$$

[25] By contrast with physical retailers, online marketplaces perceive a fee from third party sellers who directly set their prices to consumers. See Shopova (2023) for a first analysis of this issue.

$\Pi^O(h, l+\beta h)$ is concave if the determinant of the above matrix is positive. Assuming that $|\frac{\partial^2\Pi^O}{\partial q^2}| > |\frac{\partial^2\Pi^O}{\partial h\partial l}|$ guarantees that the determinant is positive. The determinant of this hessian matrix is:

$$\frac{\partial^2\Pi^{HL}}{\partial l^2}\frac{\partial^2\Pi^{HL}}{\partial h^2} - (\frac{\partial^2\Pi^{HL}}{\partial h\partial l})^2 > 0$$

A sufficient condition for the term of the diagonal $\frac{\partial^2\Pi^O(h,l+\beta h)}{\partial h^2}$ to be negative is that $\beta\frac{\partial^2\Pi^{HL}}{\partial l^2} < 2|\frac{\partial^2\Pi^{HL}}{\partial l\partial h}|$.

- U_L's profit first order condition are of the form $\alpha\frac{\partial\Pi^{HL}}{\partial l} - c'(l)$ and therefore the second order condition $\mu \equiv \alpha\frac{\partial^2\Pi^{HL}}{\partial l^2} - c''(l)$ increases in α up to $\frac{\partial^2\Pi^O(h,l+\beta h)}{\partial l^2} < 0$ implying $\mu < 0$. Moreover $R'_{U_L}(h) = -\frac{\alpha(\frac{\partial^2\Pi^{HL}}{\partial l\partial h}+\beta\frac{\partial^2\Pi^{HL}}{\partial l^2})}{\mu}$ is negative when $0 \leq \beta < \tilde{\beta}$ and positive when $\tilde{\beta} < \beta$. Note that $R'_{U_L}(h) = \frac{\frac{\partial^2\Pi^{HL}}{\partial l\partial h}+\beta\frac{\partial^2\Pi^{HL}}{\partial l^2}}{\frac{c''(l)}{\alpha}-\frac{\partial^2\Pi^{HL}}{\partial l^2}}$ strictly decreases in α when $0 \leq \beta < \tilde{\beta}$ and increases in α when $\tilde{\beta} < \beta$.[26] As $R'_{U_L}(h)$ goes from 0 when $\alpha = 0$ to $\lambda \equiv -\frac{\frac{\partial^2\Pi^O}{\partial h\partial l}}{\frac{\partial^2\Pi^O}{\partial l^2}}$. When $0 \leq \beta < \tilde{\beta}$ and $\alpha = 1$, $-1 < \lambda < 0$, it implies that $-1 < R'_{U_L}(h) < 0$. When $\tilde{\beta} < \beta$ and $\alpha = 1$, $0 < \lambda < 1$, it implies that $0 < R'_{U_L}(h) < 1$.
- U_H's profit first order condition are of the form $\alpha(\frac{\partial\Pi^{HL}}{\partial h} + \beta\frac{\partial\Pi^{HL}}{\partial l}) - c'(h)$ and therefore the second order condition $\varphi \equiv \alpha(\frac{\partial^2\Pi^{HL}}{\partial h^2} + 2\beta\frac{\partial^2\Pi^{HL}}{\partial l\partial h} + \beta^2\frac{\partial^2\Pi^{HL}}{\partial l^2}) - c''(h)$ increases in α up to $\frac{\partial^2\Pi^O(h,l+\beta h)}{\partial h^2} < 0$ implying $\varphi < 0$. Moreover $R'_{U_H}(l) = -\frac{\alpha(\frac{\partial^2\Pi^{HL}}{\partial l\partial h}+\beta\frac{\partial^2\Pi^{HL}}{\partial l^2})}{\varphi}$ is negative when $0 \leq \beta < \tilde{\beta}$ and positive when $\tilde{\beta} < \beta$. Note that $R'_{U_H}(l) = \frac{\frac{\partial^2\Pi^{HL}}{\partial l\partial h}+\beta\frac{\partial^2\Pi^{HL}}{\partial l^2}}{\frac{c''(h)}{\alpha}-\frac{\partial^2\Pi^{HL}}{\partial h^2}-2\beta\frac{\partial^2\Pi^{HL}}{\partial l\partial h}-\beta^2\frac{\partial^2\Pi^{HL}}{\partial l^2}}$ strictly decreases in α when $0 \leq \beta < \tilde{\beta}$ and increases in α when $\tilde{\beta} < \beta$.[27] As $R'_{U_H}(l)$ goes from 0 when $\alpha = 0$ to $\lambda \equiv -\frac{\frac{\partial^2\Pi^O}{\partial h\partial l}}{\frac{\partial^2\Pi^O}{\partial h^2}}$. When $0 \leq \beta < \tilde{\beta}$ and $\alpha = 1$, $-1 < \lambda < 0$, it implies that $-1 < R'_{U_H}(l) < 0$. When $\tilde{\beta} < \beta$ and $\alpha = 1$, $0 < \lambda < 1$, it implies that $0 < R'_{U_H}(l) < 1$.

[26] We have $\frac{\partial R'_{U_L}(h)}{\partial\alpha} = \frac{(\frac{\partial^2\Pi^{HL}}{\partial h\partial l}+\beta\frac{\partial^2\Pi^{HL}}{\partial l^2})\frac{c''(l)}{\alpha^2}}{(\frac{c''(l)}{\alpha}-\frac{\partial^2\Pi^{HL}}{\partial l^2})^2}$ negative when $0 \leq \beta < \tilde{\beta}$ and positive when $\tilde{\beta} < \beta$ given that $c''(l) > 0$.

[27] We have $\frac{\partial R'_{U_H}(l)}{\partial\alpha} = \frac{(\frac{\partial^2\Pi^{HL}}{\partial h\partial l}+\beta\frac{\partial^2\Pi^{HL}}{\partial l^2})\frac{c''(h)}{\alpha^2}}{(\frac{c''(h)}{\alpha}-\frac{\partial^2\Pi^{HL}}{\partial h^2}-2\beta\frac{\partial^2\Pi^{HL}}{\partial l\partial h}-\beta^2\frac{\partial^2\Pi^{HL}}{\partial l^2})^2}$ negative when $0 \leq \beta < \tilde{\beta}$ and positive when $\tilde{\beta} < \beta$ given that $c''(h) > 0$.

- I's first order condition is $\alpha\frac{\partial\Pi^L}{\partial l} + (1-\alpha)\frac{\partial\Pi^{HL}}{\partial l} - c'(l)$ and therefore the second order condition is $\kappa \equiv \alpha\frac{\partial^2\Pi^L}{\partial l^2} + (1-\alpha)\frac{\partial^2\Pi^{HL}}{\partial l^2} - c''(l)$ is monotonic in α with $\frac{\partial^2\Pi^O(h,l+\beta h)}{\partial q^2} < 0$ when $\alpha = 0$ and $\frac{\partial^2\bar{\Pi}^O}{\partial q^2} < 0$ for $\alpha = 1$ implying that $\kappa < 0$. Moreover $R_I'(h) = -\frac{(1-\alpha)(\frac{\partial^2\Pi^{HL}}{\partial l\partial h} + \beta\frac{\partial^2\Pi^{HL}}{\partial l^2})}{\kappa}$ is negative when $0 \leq \beta < \tilde{\beta}$ and positive when $\tilde{\beta} < \beta$. Note that $R_I'(h)$ strictly increases in α when $0 \leq \beta < \tilde{\beta}$ and decreases in α when $\tilde{\beta} < \beta$. When $0 \leq \beta < \tilde{\beta}$, $R_I'(h)$ goes from λ, where $-1 < \lambda < 0$, when $\alpha = 0$ to 0 when $\alpha = 1$, this implies that $-1 < R_I'(l) < 0$. When $\tilde{\beta} < \beta$, $R_I'(h)$ goes from λ, where $0 < \lambda < 1$, when $\alpha = 0$ to 0 when $\alpha = 1$, this implies that $0 < R_I'(l) < 1$.[28]

C Numerical Application

The qualities of products H and L are the sum of a baseline quality level $q_0 = h_0, l_0$ and an investment $q = h, l$ and the representative consumer's utility for products H, L thus writes as follows:

$$\nu + U_{HL} = \nu + (h+h_0)d_H + (l+l_0)d_L - \frac{1}{2}(d_H^2 + d_L^2) - \gamma d_H d_L.$$

where the parameter ν is a numeraire ($p_\nu = 1$), γ is the degree of substitutability between products H and L and d_H and d_L are the quantities of each product. Maximizing the utility of the representative-consumer with respect to d_H and d_L under the budget constraint leads to the following linear demand functions:

$$D_H^{HL}(\mathbf{p},\mathbf{q}) \equiv d_H = \frac{(h+h_0) - \gamma(l+l_0) - p_H + \gamma p_L}{1-\gamma^2}$$
$$D_L^{HL}(\mathbf{p},\mathbf{q}) \equiv d_L = \frac{(l+l_0) - \gamma(h+h_0) - p_L + \gamma p_H}{1-\gamma^2},$$

Hence the optimal industry profit is the following:

$$\Pi^{HL} = \frac{(l+l_0)^2 + (h+h_0)^2 - 2(l+l_0)(h+h_0)\gamma}{4-4\gamma^2}$$

[28] We can rewrite $R_I'(h) = \frac{\frac{\partial^2\Pi^{HL}}{\partial l\partial h} + \beta\frac{\partial\Pi^{HL}}{\partial l}}{\frac{c''(l)}{(1-\alpha)} - \frac{\alpha}{(1-\alpha)}\frac{\partial^2\Pi^L}{\partial l^2} - \frac{\partial^2\Pi^{HL}}{\partial l^2}}$. Hence, we have $\frac{\partial R_I'(h)}{\partial\alpha} = \frac{(\frac{\partial^2\Pi^{HL}}{\partial l\partial h} + \beta\frac{\partial\Pi^{HL}}{\partial l})(\frac{\frac{\partial^2\Pi^L}{\partial l^2} - c''(l)}{(1-\alpha)^2})}{(\frac{c''(l)}{(1-\alpha)} - \frac{\alpha}{(1-\alpha)}\frac{\partial^2\Pi^L}{\partial l^2} - \frac{\partial^2\Pi^{HL}}{\partial l^2})^2}$ positive when $0 \leq \beta < \tilde{\beta}$ and negative when $\tilde{\beta} < \beta$, with $\frac{\partial^2\Pi^L}{\partial l^2} - c''(l) = \frac{\partial^2\bar{\Pi}^O}{\partial l^2} < 0$ under A.5.

When only product H or L is sold, we maximize the utility of the representative-consumer with respect to d_H or d_L under the budget constraint leads to the following linear demand functions:

$$D_H(p_H, h) = h + h_0 - p_H$$
$$D_L(p_L, l) = l + l_0 - p_L$$

$$\Pi^L = \frac{(l + l_0)^2}{4}$$
$$\Pi^H = \frac{(h + h_0)^2}{4};$$

Investments costs In the main specification, we assume that the investment cost is $c(q) = q^2$.

D Sequential Investments: Integration *vs* Separation

We compare $|R'_{U_L}(h)|$ and $|R'_I(h)|$:

$$|R'_{U_L}(h)| = \frac{\alpha(\frac{\partial^2\Pi^{HL}}{\partial l \partial h} + \beta\frac{\partial^2\Pi^{HL}}{\partial l^2})}{-\mu}$$
$$|R'_I(h)| = \frac{(1-\alpha)(\frac{\partial^2\Pi^{HL}}{\partial l \partial h} + \beta\frac{\partial^2\Pi^{HL}}{\partial l^2}))}{-\kappa}$$

It is given by the following comparison:

$$\frac{\alpha}{c''(l) - \alpha\frac{\partial^2\Pi^{HL}}{\partial l^2}} \qquad \frac{(1-\alpha)}{c''(l) - (1-\alpha)\frac{\partial^2\Pi^{HL}}{\partial l^2} - \alpha\frac{\partial^2\Pi^{L}}{\partial l^2}}$$

Under A.3, $\frac{\partial^2\Pi^L}{\partial l^2} > 0$ and $\frac{\partial^2\Pi^{HL}}{\partial l^2} > 0:$

$$\alpha c''(l) - \alpha(1-\alpha)\frac{\partial^2\Pi^{HL}}{\partial l^2} - \alpha^2\frac{\partial^2\Pi^{L}}{\partial l^2} \qquad (1-\alpha)c''(l) - (1-\alpha)\alpha\frac{\partial^2\Pi^{HL}}{\partial l^2}$$

$$(2\alpha - 1)c''(l) \qquad \alpha^2\frac{\partial^2\Pi^{L}}{\partial l^2}$$

The comparison between the slope of U_L and I's reaction function is then given by:

$$sign\left[(2\alpha-1)c''(l)-\alpha^2\frac{\partial^2\Pi^L}{\partial l^2}\right].$$

Additionally, U_H invests more under vertical integration when the buyer power becomes higher:

$$\frac{\partial\left[(2\alpha-1)c''(l)-\alpha^2\frac{\partial^2\Pi^L}{\partial l^2}\right]}{\partial\alpha}=2c''(l)-2\alpha\frac{\partial^2\Pi^L}{\partial l^2}<0$$

This yields to:

$$\frac{\partial}{\partial\alpha}\left[|R'_{U_L}(h)|-|R'_I(h)|\right]<0.$$

E Industry Profit and Welfare under a Leading Manufacturer

When $\alpha = 1$ (low buyer power), there are investment distortions in the two market structures which make the comparison unclear with a general demand. We thus focus below on the particular case in which buyer power is large (i.e. $\alpha = 0$)

When investments are sequential, it is desirable from an industry perspective to have U_H that invests first and I second rather than U_L whenever the buyer power is large. We further show that, in the linear case, it is desirable from an industry perspective to have U_H that invests first and U_L second.

When $\alpha = 0$, there is no investment in the vertical separation case and the corresponding industry profit is $\Pi^O(0,0)$. In the vertical integration case, U_H still does not invest but I now invests $l_2^i(0) = l^O(0)$ when being a follower. Therefore, when $\alpha = 0$, the industry profit is $\Pi^O(0, l^O(0))$ and $\Pi^O(0,0) < \Pi^O(0, l^O(0))$. By continuity, when the buyer power is large, for α sufficiently close to 0, it is desirable for the industry to have the retailer investing when investments are either substitutes or complements.

With a linear demand, in the presence of a leading manufacturer, vertical integration is profitable for the industry whenever $\alpha < \tilde{\alpha_1}$ (resp. $\alpha < \tilde{\alpha_2}$) with low (resp. high) spillovers. Moreover, vertical integration is welfare improving whenever $\alpha < \tilde{\alpha_3}$ when spillovers are low and for all α when spillovers are high.

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