Vertical integration and product differentiation[1]

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We study a new channel of downstream rent extraction through vertical integration: competition for integration. Innovative downstream firms create value and profit opportunities through product differentiation, which however affects an upstream monopolist's incentive to vertically integrate. By playing the downstream firms against each other for integration, the upstream firm can extract even more than the additional profits generated by the downstream firms' differentiation activities. To preempt rent extraction, the downstream firms may then reduce differentiation, which reduces social welfare. We show that this social cost of vertical integration is more likely to arise in innovative and competitive industries, and that the *competition for integration channel* of downstream rent extraction is robust to upstream competition.

Key Words: Vertical integration; product differentiation; rent extraction; product innovation, market segmentation.

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1. INTRODUCTION

The welfare consequences of vertical mergers are highly controversial in competition policy. A variety of pro-competitive efficiency gains, from the elimination of double marginalization to the solution of incentive problems caused by incomplete contracts, have traditionally been contrasted with a major anti-competitive concern, *vertical foreclosure*, whereby vertically integrated firms would gain market power by restricting supply (or demand) to downstream (upstream) competitors.[4]

Important merger and consolidation waves in high-tech industries (such as pharmaceutical, biotech, electronics, energy, ITC, software, smartphones) since the early 90s, have more recently turned the attention of antitrust authorities and scholars towards the effects of vertical mergers on firms' innovation activities.[5] For instance, discussing the case of *Silicon Graphics*' acquisition of *Alias and Wavefront,* Christine Varney (1995)[6] points at product innovation, positioning and design as possible channels of anti-competitive effects of vertical mergers: "*[...] the combined entity would not need to bar other software developers completely, but could redirect them away from direct competition by, for example, encouraging the development of products that are complement to, rather than direct substitutes for, Alias and Wavefront software*". More generally, the 2008 EU Guidelines on the assessment of non-horizontal mergers treat reduction in innovation, quality and choice of goods and services as sufficient reasons to prevent mergers on equal footing with anti-competitive price increases and output restrictions.[7]

An interesting literature (discussed in detail in a separate section) has then arisen on the interplay between firms' vertical relations and innovation, contrasting the incentives to innovate of vertically integrated firms, their separated competitors, and their non-integrated counterparts, and investigating how innovation activities, in turn, affect firms' incentives for vertical integration.

This paper contributes to this literature in two important ways. First, we focus on independent firms' innovation activities, such as product design, development, and market positioning, which, while generating value to final consumers, are also likely to spill over profit opportunities to differentiated competitors, for instance by

[4] Vertical foreclosure has been investigated by a vast literature in a variety of vertical integration models, e.g., Salinger (1988), Ordover et al. (1990), Hart and Tirole (1990), Riordan and Salop (1995), Riordan (1998), Choi and Yi (2000), Chen (2001), Chen and Riordan (2004). See Rey and Tirole (2007) and Riordan (2008) for excellent surveys of this literature.

[5] The US Department of Justice (DOJ) and Federal Trade Commission (FTC) have strengthened their focus on innovation since the mid-90s, formalizing the application of the antitrust laws to innovative markets. As for vertical mergers, the DOJ Antitrust Division underlined that, under certain conditions, vertical mergers may chill innovation (Sunshine, 1994). As reported in Gilbert (2005), since then the proportion of US merger challenges where the DOJ and FTC raised concerns about adverse innovation effects has increased from 3% (in the period 1990-1994) to 18% (for the period 1995-1999) and 38% (for the period 2000-2003).

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[7] Adverse effects on innovation have consequently been investigated by the Commission in a number of recent cases of non-horizontal mergers, including *Intel/Mc Afee*, *Arm/Gieseke & Devrient/Gemalto Joint Venture*, and *Telefonica UK/Vodafone UK/Everything Everywhere Joint Venture*. For an interesting discussion of these cases, see *Competition policy brief* (April 2016).

creating new contestable markets, enlarging existing ones, and strengthening horizontal differentiation. Second, we account for the highly competitive environment which characterizes the merger and acquisition activity in innovative industries,[8] by studying a new channel of downstream rent extraction through vertical mergers, *competition for integration*, and its effect on the independent firms' incentive for product innovation and social welfare.

In a nutshell, while the profit opportunities created by independent downstream innovators can attract vertical takeovers,[9] the spillover effects of said innovation activities would render all affected downstream firms good alternative targets for these takeovers, potentially competing for integration. We show that, by triggering this competition, the upstream firms may even extract more than the downstream rents produced by the innovation activities. Anticipating these effects, the downstream innovators may refrain from investing in profitable and socially valuable innovations.

Our baseline model assumes a simple *linear-pricing* vertical setting,[10] where two innovative downstream firms produce a final product using a generic input supplied by an upstream monopolist. At the outset, the downstream firms decide the degree of horizontal differentiation of their varieties of final product. Product differentiation directly carries value to final consumers and hence enlarges total demand, but it also yields downstream market segmentation, with positive effects on downstream profits and anti-competitive effects on final prices.[11] Crucially, it affects the upstream monopolist's incentive to vertically integrate too. Once the differentiation decision has been taken, the upstream monopolist can call the downstream firms for independent price offers in order to vertically merge with one of them (at a fixed integration cost). Either vertical separation or partial vertical integration can emerge from this game. Vertical separation would leave the downstream market as a symmetric duopoly of independent downstream firms. Vertical integration would lead to an asymmetric duopoly, where the integrated firm optimally prices the essential input to its downstream rival, the independent

[8] M&A on-line reviews and specialized intermediaries websites (e.g., investment bankers, business brokers, investment management firms) immediately convey an idea of intense strategic competition. For instance, Karl Hunt (*ABI Capital*) stresses the importance of merger competition as one of the takeovers patterns which offer systematic profit opportunities to investors: "*Takeovers often come in bunches – companies receiving bids are likely to see their competitors receive bids too. Investment bankers perform the same analysis and submit the same ideas for growth and consolidation to numerous clients*" (*ABI Capital* website: http://apicapital.com/2017/01/20/takeover-targets/). A thorough illustration of the competitive environment of the US *Middle Market* M&A activities can be found in Roberts (2009).

[9] Alfaro et al. (2016) provides interesting empirical evidence that, rather than triggering high market prices through anti-competitive foreclosure, vertical mergers tend to be triggered by the profit opportunities signalled by high market prices.

[10] Non-linear pricing has been extensively studied in the vertical relations literature, but it is far from ubiquitous or fully efficient in the real world. Accordingly, a significant part of this literature posits linear pricing and assumes, as we do, that vertical integration fixes or softens double marginalization. See, among many others, Salinger (1988), Ordover et al. (1990), Colangelo (1995), Economides (1998), Hackner (2003), Arya et al. (2008).

[11] Here and throughout the paper, the term "market segmentation" is used in the broad sense of a decrease in each firm's demand sensitivity to competitors' price changes.

firm, and to its own downstream division.[12]

In this setting, vertical integration occurs in equilibrium only if it is *profitable*, in the sense that it offers the two merging firms a positive *net surplus from integration*: the integrated firm's profit, net of the integration cost, exceeds the total profit the two merging firms would gain under vertical separation. As explained later on, however, competition for integration sets the takeover price finally reaped by the merged downstream firm at its outside option under vertical integration, that is, the equilibrium profit of an independent firm, as weakened by the strong competitive advantages of the integrated firm. This *competition for integration channel* of rent extraction allows the upstream firm to reap more than the *net surplus from integration*, and even to extract more than the overall downstream rents generated by product differentiation. As a consequence, the downstream firms perceive vertical integration as a threat to be *preempted*, if possible, by setting product characteristics that make vertical integration unprofitable. Otherwise, they set product characteristics such as to *soften rent extraction* by maximizing the prospective profit of an independent firm under vertical integration, and hence the takeover price.

Thus, how the threat of vertical integration affects product differentiation crucially depends on how the *net surplus from integration* is affected by product differentiation. There are two sources of integration surplus in our model: *double marginalization softening* and *business stealing via rival's cost raising* (or *price squeeze*, in the antitrust law terminology). By charging a low input price to its downstream division, an integrated firm can profit from softening (or even eliminating) double marginalization from its segment of the downstream market (*double marginalization softening source*). By opening a positive gap between the external and the internal input prices, it can steal market share and profits from its downstream rival, the independent firm (*business stealing source*). Product differentiation strengthens the *double marginalization softening source*, as it enlarges the total market size (by creating new value to consumers) and increases the downstream profit margins (by segmenting the downstream market). It however weakens the *business stealing source*, as the integrated firm's final demand becomes less elastic to the independent firm's price when the downstream market is more segmented.

One of the contributions of our paper is to show that the relative strength of these two sources of integration surplus, and hence the resulting effect of the vertical integration threat on product differentiation, crucially depend on two economic forces: the size of the value creating content of product differentiation (captured by the *market size effect* of differentiation), and the intensity of downstream competition (captured as a switch from *Cournot* to *Bertrand* competition). When downstream competition is *soft* (*Cournot competition*), the integration surplus is high either with strong differentiation (as the *double marginalization softening source* of surplus is strong here) or with weak differentiation (as the *business stealing source*

[12] All our results go through under the alternative assumption that the integrated firm simply transfers the essential input to its downstream division at cost. As discussed in detail below, this assumption would however hinder interpretation. Besides this clarification role, our partially integrated duopoly with optimal internal input pricing may also be of some independent interest.

becomes strong there). Therefore, the downstream firms' incentive to preempt vertical integration may either weaken or strengthen their incentive for differentiation. Even in this case, however, when product differentiation potentially offers high social value (strong differentiation opportunities), vertical integration preemption reduces differentiation. When downstream competition is *intense* (*Bertrand competition*), the integration surplus monotonically increases with product differentiation, which implies that vertical integration preemption now unambiguously reduces product differentiation. The intuition, detailed later on in the paper, relies on a dampening effect of intense downstream competition on the business stealing source of integration surplus when products are weakly differentiated. In terms of social welfare, as long as the value creating content of product differentiation dominates the anti-competitive effect of market segmentation, as in our baseline model, social welfare is harmed by any preemptive reduction in differentiation.

We present three extensions of the baseline model. The first eliminates the *market size effect* (i.e., the value creating content) of product differentiation, which then turns into mere market segmentation. We show that vertical integration preemption always strengthens differentiation in this case, which however harms social welfare now. This finding confirms the crucial role played by the value creating content of differentiation in our previous results. It also suggests that while a threat of downstream rent extraction *via* competition for integration is likely to cause a social cost in terms of less product innovation in innovative and competitive industries, it is likely to cause a social cost in terms of anti-competitive market segmentation in mature industries, where the value creating content of differentiation is probably limited.

The second extension models competition at the product differentiation stage, showing that, albeit important, the effects of non-cooperative differentiation are to a large extent orthogonal to the effects of the vertical integration threat on product differentiation.

The last extension accounts for upstream competition. We show not only that our *competition for integration channel* of downstream rent extraction is robust to upstream competition if, as intuition suggests, the upstream firms have sufficiently high bargaining power at the integration stage, but also that its effects can be amplified by competition for integration being played by vertical pairs of firms, which can cause over-investment in vertical integration and downstream rent dissipation.

We postpone the discussion of the literature, policy implications, and further motivating examples after we have presented the model and derived our results. The resulting organization of the paper is as follows. Section 2 presents the baseline model. Section 3 analyzes the *competition for integration channel* of downstream rent extraction. Section 4 presents our main results on the effects of the vertical integration threat on product differentiation. Section 5 collects the three extensions. Section 6 discusses the literature. Section 7 offers further motivation and policy discussion, and some conclusive remarks. Appendix 1 shows the main proofs, but most of the analytical work is collected in the on-line appendix 2.

2. THE BASELINE MODEL

Setting and production technology. We consider an industry with upstream and downstream markets. The upstream market is monopolized by firm U,[13] which produces (for simplicity at zero cost) the sole input needed by two downstream firms, D_1 and D_2, to produce the final product with a *one-to-one technology*: one unit of essential input for each unit of final product. The final product comes in two varieties, variety 1 and variety 2, each of them exclusively produced and sold to final consumers by the homonymous downstream firm. Said varieties can be homogeneous or horizontally differentiated according to a product differentiation decision taken by the downstream firms before the production stage. Their final degree of substitutability in demand, γ, may range from 0 (independent products) to 1 (perfect substitutes).

Stages and timing. The model consists of three sequential stages, illustrated separately below. In stage 1, the downstream firms set the degree of product differentiation. In stage 2, the vertical structure of the industry is determined as the outcome of a competitive integration game.[14] If vertical integration occurs, the upstream monopolist vertically integrates with one of the two downstream firms.[15] In this case, we will refer to the integrated firm as to firm I, and to the downstream independent firm as to firm N. If vertical integration does not occur, we are left with the vertically separated structure of the industry mentioned before. In stage 3, first the essential input is optimally priced by the upstream monopolist, under vertical separation, or by the upstream division of the vertically integrated firm, under vertical integration. Then, duopoly competition takes place in the downstream market: between the two downstream firms, under vertical separation, or between the independent firm and the downstream division of the integrated firm, under vertical integration. Production and profits are finally determined.

Product differentiation stage. Either it consists of innovative product design or mere market segmentation, horizontal product differentiation typically involves externalities across competitors, which clearly play an important role in firms' competitive incentives to invest in differentiation (see, e.g., Lambertini and Rossini, 1998). In our setting, such externalities are rather more important for enabling the upstream firm to trigger downstream competition for vertical integration than for their direct effect on the downstream incentive for differentiation. As for the

[13] In section 5.3, we extend the model to upstream competition.

[14] The relative timing of the differentiation and the integration stages rests on the idea that product design, positioning, and marketing may be less reversible than the organizational form of vertical relationships. Upstream firms may also lack sufficient expertise of the final market to assess the potential value of new products or publicity campaigns, and hence to determine takeover prices, before those products or campaigns are developed and launched, and the downstream firms' investments in them are sunk.

[15] Like many other works on vertical integration (e.g., Hart and Tirole, 1990), we assume away horizontal mergers, likewise the complete integration of the industry in a single monopoly. Both assumptions can be motivated by the antitrust authorities banning horizontal or vertical mergers leading to the full monopolization of the downstream market or of the entire industry. Prohibitive re-organization costs may also justify the assumption that vertical integration cannot involve both downstream firms.

latter, our focus is on the effect a prospective threat of vertical integration exerts on it, and modelling competition at the differentiation stage strongly complicates the analysis without adding much insight on this effect. For these reasons, we initially abstract from any strategic aspect related to competition at the differentiation stage. We concentrate on the downstream firms' incentive for product differentiation as measured by the joint-profit gain they would derive from a reduction in product substitutability, γ, from 1 (the perfect substitutes extreme) to any given lower value $\widehat{\gamma} \in [0, 1)$. We will denote it by $\widehat{k}(\widehat{\gamma})$.[16] We then contrast differentiation incentives and costs when we assess the welfare effects of vertical integration through its impact on product differentiation. Finally, in section 5.2 we extend the model to non-cooperative differentiation, and discuss robustness of our results.

Integration game. In our model, the upstream firm has identical opportunities to appropriate downstream value and profits generated by product differentiation by merging with any of the two downstream firms. It is therefore in the position of triggering downstream competition for integration after the differentiation decision has been taken by the downstream firms. We model the vertical integration stage as a first-price auction. The upstream monopolist calls the downstream firms for simultaneous and independent price offers in order to integrate with one of them. On the basis of the offers received, the upstream monopolist then decides whether to vertically integrate with the downstream firm asking for the lowest price, thus paying the lowest bid. In the case of tie, we assume that each downstream firm has fifty percent probability of merging with the upstream firm, should the latter decide to accept the offer. We further assume that vertical integration involves a fixed integration cost, denoted by E.[17] In section 5.3, we show robustness of our *competition for integration channel* of downstream rent extraction to upstream competition by extending the model to a successive duopoly, and the integration stage to a simultaneous integration game played by predetermined pairs of upstream and downstream firms.

Market stage. The *competition for integration channel* of downstream rent extraction can be shown without assuming any specific model for the downstream market. In this part of the analysis, we just adopt a reduced-form of the firms' equilibrium profits which encompasses a range of horizontally differentiated duopoly models.[18] The upstream incentive for integration, and the effects of vertical integration on product differentiation and welfare, however, crucially depend on the combination of two economic forces at work in the downstream market: the intensity of downstream competition (captured here as a switch from *Cournot* to *Bertrand* competition) and the value creating content of product differentiation (captured here by a *market size effect* of differentiation). To show the role of

[16] The perfect substitutes extreme, $\gamma = 1$, is used here just as a convenient reference point to measure the incentive for differentiation. In fact, in our model, the downstream firms' joint-profit gain from differentiating products from any initial degree $1 - \gamma_\bullet$ to any final degree $1 - \widehat{\gamma} > 1 - \gamma_\bullet$ is always given by the difference $\widehat{k}(\widehat{\gamma}) - \widehat{k}(\gamma_\bullet)$.

[17] See Hart and Tirole (1990) for an extensive discussion of the organizational, incentive, and legal costs of vertical integration which can be summarized in a fixed integration cost term.

[18] As intuitively argued below and formally shown in appendix 2.

these forces, we will then "unbundle" the reduced-form adopting a standard linear quadratic specification of consumers' preferences.

3. RENT EXTRACTION *VIA* COMPETITION FOR INTEGRATION

The reduced-form assumes regular and symmetric demand functions of the two varieties of final product.[19] Under vertical separation, the upstream firm optimally sets a symmetric price for the essential input supplied to the two downstream firms, $w_D(\gamma)$, leading to a symmetric duopoly equilibrium in the downstream market. $\pi_U(\gamma)$ and $\pi_D(\gamma)$ will denote the equilibrium profits of the upstream firm and each of the two downstream firms; $p_D(\gamma)$ and $q_D(\gamma)$ the symmetric price and quantity of each variety of final product.

Under vertical integration, the integrated firm optimally prices the essential input supplied to the independent firm and to its own downstream division.[20] Consistently with intuition, we assume that the internal input price charged to its own downstream division, $w_{D_I}(\gamma)$, never exceeds the external input price charged to the independent firm, $w_N(\gamma)$, so that the resulting downstream equilibrium is generally asymmetric.[21] $\pi_N(\gamma)$, $\pi_{D_I}(\gamma)$, and $\Pi_I(\gamma)$ will denote the equilibrium profits of the independent firm, the downstream division of the integrated firm, and the overall integrated firm, respectively; $p_N(\gamma)$ and $q_N(\gamma)$ the equilibrium price and quantity of the independent firm's variety of final product; $p_{D_I}(\gamma)$ and $q_{D_I}(\gamma)$ those of the integrated firm's variety.[22] The reduced-form finally posits:

Assumption 1.

A1.1) $\pi'_N(\gamma) < 0, \quad \pi'_D(\gamma) < 0, \quad \forall\gamma \in [0,1].$

A1.2) $\pi_N(\gamma) < \pi_D(\gamma), \quad \forall\gamma \in (0,1).$

A1.3) $\pi_N(\gamma) > 0, \quad \forall\gamma \in [0,1); \quad \pi_N(1) = 0.$

Part A1.1 states that the equilibrium profits of both the independent firm (under vertical integration) and any downstream firm (under vertical separation) monotonically increase with product differentiation (i.e., they monotonically decrease with

[19] Symmetry in demand just eliminates distracting sources of firm asymmetry than vertical relationships.

[20] As explained later on, assuming that the integrated firm just transfers internally the input at zero-price would not affect any of our results. In our analysis, however, this assumption would artificially restrict the integrated firm's ability to set high input prices to contrast industry profit erosion due to downstream competition, a strategy on the contrary always feasible for a separated upstream firm. Then, for a spurious reason, the upstream firm's incentive to integrate would become negative when downstream competition is intense (Bertrand competition) and varieties are close substitutes.

[21] In the linear quadratic specification of the downstream market adopted in the next section, $w_N(\gamma)$ strictly exceeds $w_{D_I}(\gamma)$ except under Bertrand competition with perfect substitute varieties ($\gamma = 1$).

[22] Dropping the functional notations, profits are defined as: $\pi_D = (p_D - w_D)\,q_D$ and $\pi_U = 2w_D q_D$, under vertical separation; $\pi_N = (p_N - w_N)\,q_N$, $\pi_{D_I} = (p_{D_I} - w_{D_I})\,q_{D_I}$, and $\Pi_I = \pi_{D_I} + w_N q_N + w_{D_I} q_{D_I}$, under vertical integration.

γ). This reflects both the value creating content of product differentiation, expanding final demand and profits, and its anti-competitive effect *via* market segmentation, increasing the equilibrium prices and profits of symmetric competitors (the two downstream firms under vertical separation), as well as the equilibrium price and profit of a high cost competitor (the independent firm under vertical integration).

Part A1.2 relies on the tougher competitive pressure faced by the independent firm under vertical integration (i.e., competition from the integrated firm, which can set the downstream marginal costs), relative to the competitive pressure faced by any downstream firm under vertical separation (i.e., competition from a symmetric competitor).[23]

Finally, part A1.3 shows the effect of product differentiation on the possibility of market foreclosure under vertical integration. Competing away downstream market share and profits gives the integrated firm a strategic incentive to raise the independent firm's cost,[24] which would however reduce input sales. Intuitively, the strategic incentive to raise the rival's cost weakens with product differentiation (it vanishes altogether when varieties are independent in demand).

Consider now the integration game. The two downstream firms carries identical value as potential targets for the upstream firm's takeover. Furthermore, they symmetrically face the risk of being left in the weak profit position of an independent firm under vertical integration (stated in A1.2). Competition for integration, however, will be effective only if vertical integration overall promises a net surplus to the merging firms. Formally, we call *gross surplus from integration*, $S(\gamma)$, the difference between the overall profit of a vertically integrated firm and the overall profits the two firms potentially involved in the merger (the upstream monopolist and one downstream firm) would gain under vertical separation:

$$S(\gamma) = \Pi_I(\gamma) - \pi_U(\gamma) - \pi_D(\gamma). \tag{1}$$

Integration is profitable if the gross surplus from integration exceeds the fixed integration cost:

$$S(\gamma) - E > 0. \tag{2}$$

Assume now that the merger takes place at a takeover price P. The upstream monopolist's net gain from merging (compared to vertical separation) would be:

$$\Pi_I(\gamma) - \pi_U(\gamma) - P - E,$$

or, using (1),

$$(S(\gamma) - E) + (\pi_D(\gamma) - P). \tag{3}$$

With these preliminaries in place, the following lemma characterizes the equilibrium outcome of the integration game in terms of the profitability condition (2), showing the *competition for integration channel* of downstream rent extraction.

[23] Although not specified in A1.2, with perfect substitute varieties, $\gamma = 1$, we must allow either for $\pi_D(1) > \pi_N(1) = 0$ or for $\pi_D(1) = \pi_N(1) = 0$ to encompass Cournot (first case) and Bertrand competition (second case). With independent varieties, $\gamma = 0$, downstream competition vanishes, so that $\pi_N(0) = \pi_D(0)$.

[24] As first argued by Salop and Scheffman (1983).

Lemma 1. *If condition (2) holds, then vertical integration occurs in equilibrium at the takeover price $P^* = \pi_N(\gamma)$, so that both the merged and the independent downstream firms finally earn $\pi_N(\gamma)$. If condition (2) is violated, then vertical integration does not occur in equilibrium, so that both downstream firms finally earn $\pi_D(\gamma)$.*

When vertical integration is profitable, competition between the downstream firms to be integrated causes the merging downstream firm to reap just its outside option under vertical integration: the equilibrium profit of the independent firm, $\pi_N(\gamma)$. The upstream monopolist, in contrast, collects more than the net surplus from integration, as it is apparent from equation (3) once recalled that $\pi_D(\gamma) > \pi_N(\gamma)$ by A1.2. When, on the contrary, vertical integration is not profitable, in equilibrium the downstream firms independently refrain from competing for integration, thereby avoiding integration.[25]

From lemma 1 we gain intuition of two strategic motives the *competition for integration channel* of rent extraction introduces in the downstream firms' incentive for product differentiation: 1) preempt integration by inducing, if possible, a negative net surplus from integration; 2) sustain the independent firm's profit, and hence the expected takeover price, if integration cannot be avoided.

4. VERTICAL INTEGRATION AND PRODUCT DIFFERENTIATION

In view of lemma 1, the effect of product differentiation on the vertical structure of the industry, and hence on the threat of rent extraction, rests on the sign of the *net surplus from integration*, $S(\gamma) - E$, over the product substitutability range $\gamma \in [0, 1]$. In this section, we first show how downstream market competition combines with the value creating content of product differentiation to shape the *gross surplus from integration*, $S(\gamma)$, and hence the upstream firm's incentive for integration. We then turn to the effect of the vertical integration threat on the downstream firms' incentive to differentiate products and welfare.

4.1. Product differentiation and upstream incentive to integrate

In our model, an integrated and a separated upstream firm can equally use the input prices to contrast industry profit erosion due to downstream competition. Furthermore, an integrated firm can always replicate the vertical separation equilibrium by charging, internally and externally, the same (symmetric) input price a separated upstream firm would optimally choose. Therefore, the gross surplus from integration can never be negative.

Positive integration surplus can come from two advantages of vertical integration, obviously linked to the consequent ability for the upstream firm to collect downstream profits directly: 1) by setting a low internal input price, the integrated

[25] To be precise, when condition (2) is violated the game admits two equilibrium outcomes. As only the one in the statement survives the application of commonly used refinement criteria like Pareto dominance, risk dominance, and trembling hand perfection, we adopt it as the most natural outcome when integration is not profitable (see the proof of the lemma in appendix 1).

firm can profit from softening or even eliminating double marginalization in its segment of the downstream market (*double marginalization softening*); 2) by opening a gap between the external and the internal input price, it can compete away downstream market share and profits from the independent firm (*business stealing via rival's cost raising*).

The first source of integration surplus strengthens with product differentiation, as downstream profit margins, and hence the gain from softening double marginalization, increase when the market becomes more segmented. Moreover, it is boosted by any direct value consumers may derive from product differentiation, as the downstream market size, and hence the gain of avoiding double marginalization in one segment of it, would increase. The second source, on the contrary, weakens with product differentiation, as the integrated firm's final demand becomes less elastic to the independent firm's price when final products are more differentiated. Such a *business stealing value* of vertical integration is however crucially affected also by the intensity of competition in the downstream market: as we show below, intense downstream competition (i.e., Bertrand rather than Cournot competition) dampens this source of surplus from integration when products are weakly differentiatied, that is, exactly in the case where this source would tend to be strong.

We illustrate these effects within a standard linear-quadratic model of differentiated duopoly, which generates all properties we assumed for the reduced-form of section 3.[26] Preferences of the representative final consumer are specified as: [27]

$$U = a(q_1 + q_2) - \frac{1}{2}\left(q_1^2 + q_2^2 + 2\gamma q_1 q_2\right) + m, \tag{4}$$

leading to the inverse demand system for the two varieties of final product:

$$p_i = a - q_i - \gamma q_j \quad (i, j = 1, 2;\ i \neq j). \tag{5}$$

Notice that product differentiation directly generates social value to consumers in this model: for given quantities (q_1 and q_2), utility (4) and demand prices (5) increase with product differentiation (i.e., they decrease with γ).

Vertical integration and vertical separation equilibria, under Cournot and under Bertrand competition, are detailed in appendix 2. Here we focus on the resulting shapes of the gross surplus from integration (1) over the product substitutability range $\gamma \in [0, 1]$, and their intuition.

Proposition 1. *If downstream competition is soft (Cournot competition), the gross surplus from integration, $S^C(\gamma)$, is U-shaped in product substitutability, γ, with global maximum at $\gamma = 0$. If downstream competition is intense (Bertrand competition), the gross surplus from integration, $S^B(\gamma)$, monotonically decreases*

[26] Originally introduced by Bowley (1924), this model has been subsequently popularized by Spence (1976), Dixit (1979), and Sing and Vives (1984).

[27] In (4) and (5) below: a is a positive parameter (fixing the height of the demand functions); q_1, q_2 and m denote the consumption of variety one, variety two, and a numeraire good; p_1 and p_2 are the prices of the two varieties. Maximizing utility (4), subject to the budget constraint $p_1 q_1 + p_2 q_2 + m = R$, gives the demand system (5).

with product substitutability, γ (i.e., it monotonically increases with product differentiation), vanishing at $\gamma = 1$.

The U-shaped pattern of the gross surplus from integration under Cournot competition is illustrated in Figure 1a, and its monotonically decreasing pattern under Bertrand competition is shown in Figure 1b. Notice that the gross surplus from integration is unaffected by the intensity of downstream competition when varieties are independent in demand: $S^C(0) = S^B(0) \equiv S(0)$.

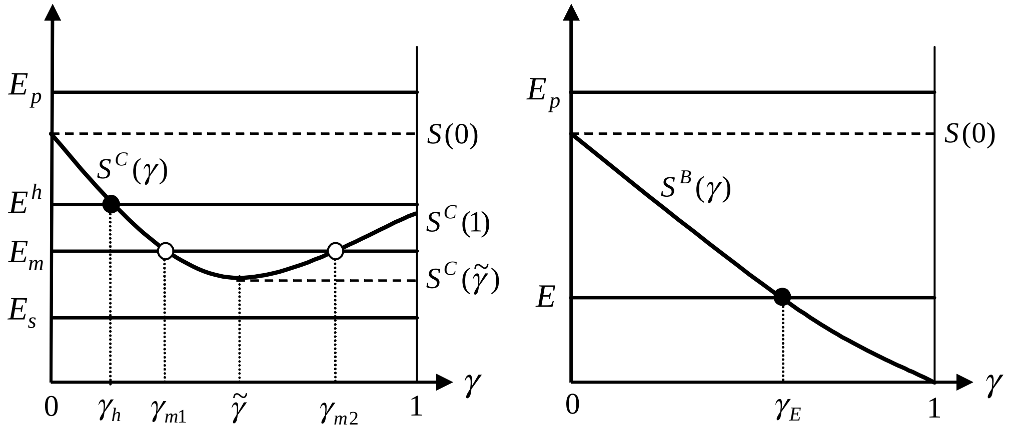

Figure 1a Figure 1b

The interpretation of the U-shaped surplus under Cournot competition immediately relates to our previous discussion of the two sources of integration surplus. The surplus is high with strongly differentiated products (low values of γ) because the first source, *double marginalization softening*, is strong there; it turns high again with poorly differentiated products (high values of γ) because the second source, *business stealing via rival's cost rising*, becomes strong when products are close substitutes. Following this interpretation, the monotonic pattern of the integration surplus under Bertrand competition should arise from a dampening effect intense downstream competition would exert on the *business stealing source* of integration surplus, making the shape of the gross surplus mirror the monotonically decreasing (in γ, increasing in differentiation) strength of the *double marginalization softening source*.

To show this dampening effect, consider the case of perfect substitutes ($\gamma = 1$). Under Bertrand competition, a separated upstream firm would be able to induce and reap the (maximum) industry monopoly profit by symmetrically pricing the input at the monopoly price of the final product, as downstream profit margins are zero. A vertically integrated firm can at most reach the same profit, but now adopting any of the following two equivalent strategies: 1) the same as the *separated upstream firm's strategy*, that is, setting both the internal and the external input prices at the final product monopoly price, thereby collecting the full monopoly profit as upstream division profit; or 2) a *foreclosure-business stealing strategy*, which consists in pricing the input internally at (zero) cost, and externally at a level sufficiently high to allow its downstream division to engage in monopoly pricing without the fear of being displaced by the independent firm, thereby collecting the full monopoly profit as downstream division profit. Now, since an integrated and a separated upstream firms would make the same profit (and downstream profits are zero in the vertical separation equilibrium), the *gross surplus from integration* is nil under Bertrand competition. Furthermore, the *business stealing (foreclosure) value* of vertical integration is nil as well, as the *foreclosure strategy* does not offer any extra profit opportunity to an integrated firm. Under Cournot competition, on the contrary, the *gross surplus from integration* is positive exactly because of a positive *business stealing (foreclosure) value* of vertical integration. As downstream profit margins are positive now, a separated upstream firm will never be able neither to induce nor to collect the full monopoly profit in the industry. An integrated firm, in contrast, will be able to do both, but only through (that is, thanks to) the *foreclosure-business stealing strategy.*

Back to Bertrand competition, any slight degree of product differentiation breaks the tie between the strategies mentioned above, making the integrated firm strictly prefer a strategy of (almost symmetrically) high external and internal input prices (close to the pricing strategy of a separated upstream firm) over a *foreclosure-business stealing* strategy of large gaps between the external and the internal input prices. Indeed, while the main potential problem with the first strategy, double marginalization, is still negligible, the second strategy would now waste the opportunity to extract at least part of the consumers' gain from variety in the form of upstream profits.[28] More generally, smaller downstream profit margins under intense competition make it relatively more efficient to generate and collect industry profits (in the form of upstream profits) *via* high input prices, which reduces the *business stealing value* of vertical integration.[29]

[28] Interestingly, constraining the integrated firm to transfer the input internally at zero-price would only affect the shape of Bertrand gross surplus from integration. From $\gamma = 0$, it would now monotonically decrease with γ down to a negative minimum, increasing then in γ up to zero as varieties become perfect substitutes. At the perfect substitutes extreme, the integrated firm would now be constrained to collect the full monopoly profit through the foreclosure strategy, while a separated upstream firm would still do so by symmetrically pricing the input at the final product monopoly price. While the surplus from integration would still be zero at $\gamma = 1$, it would turn negative for mild degrees of differentiation. This confirms that, from the viewpoint of the integrated firm, price strategies of high but relatively equalized input prices (close to a separated upstream firm's pricing) dominate strategies of wide input price gaps (and strong business stealing) when competition is intense and products are close substitutes. Notice finally that the above changes in Bertrand integration surplus would anyway leave our results unaffected: for negative values, the shape of the surplus is irrelevant for the incentive to differentiate products, and monotonicity is preserved for positive values.

[29] In the linear-quadratic model, the optimal external input price set by an integrated firm, $w_N(\gamma)$, always equals the (symmetric) input price a separated upstream firm would optimally charge, $w_D(\gamma)$, irrespective of the mode of competition and γ. The difference in the integrated firm's pricing strategies under the two modes of competition arises from the internal input price, $w_{D_I}(\gamma)$. Under Cournot, $w_{D_I}(\gamma)$ is always lower than $w_N(\gamma)$, and shows an inverted U-shaped pattern in γ: it starts at zero (the marginal cost) at $\gamma = 0$, and ends at zero at $\gamma = 1$. Under Bertrand, $w_{D_I}(\gamma)$ monotonically increases with γ, again starting at zero at $\gamma = 0$, but reaching now the external price $w_N(\gamma)$ at $\gamma = 1$.

Turning to the integration stage of the model, lemma 1 and proposition 1 immediately imply the vertical structure of the industry that will emerge from the integration game as a function of the intensity of downstream competition, the degree of product differentiation, γ, and the integration cost level, E.

COROLLARY 1. *With soft downstream competition (Cournot competition), vertical integration arises in equilibrium: i) for any value of* γ *if integration costs are small:* $E_s \in [0, S^C(\widetilde{\gamma})]$;[30] *ii) for high or for low, but not for intermediate, values of* γ *if integration costs are intermediate:* $E_m \in (S^C(\widetilde{\gamma}), S^C(1))$; *iii) for low values of* γ *if integration costs are high:* $E_h \in [S^C(1), S(0))$; *iv) for no values of* γ *if integration costs are prohibitive:* $E_p \geq S(0)$.

COROLLARY 2. *With intense downstream competition (Bertrand competition), vertical integration arises in equilibrium: i) for sufficiently low values of* γ *if the integration costs are non-prohibitive:* $E \in (0, S(0))$; *ii) for no values of* γ *if integration costs are prohibitive:* $E_p \geq S(0)$.

Corollaries 1 and 2 are illustrated in Figures 1a and 1b, respectively. In Figure 1a, representative values for the four classes of integration costs of corollary 1 are marked on the vertical axis. The net surplus from integration is always positive with the small cost E_s, and always negative with the prohibitive cost E_p. With the intermediate cost E_m, it is negative in the intermediate interval of product substitutability $[\gamma_{m1}, \gamma_{m2}]$, positive outside that interval. With the high cost E_h, the net surplus from integration is positive in the interval $[0, \gamma_h]$, negative outside it. In Figure 1b, the illustration of corollary 2 just requires an example of prohibitive costs, E_p, whereby the net surplus from integration is always negative, and one of non-prohibitive costs, E, whereby the net surplus is positive in the interval $[0, \gamma_E]$, negative outside it.

4.2. VERTICAL INTEGRATION AND DOWNSTREAM INCENTIVE FOR DIFFERENTIATION

At the differentiation stage, the two downstream firms hold identical profit expectations under any future evolution of the game: the independent firm's profit $\pi_N(\gamma)$, under vertical integration (by lemma 1); the symmetric downstream profit $\pi_D(\gamma)$, under vertical separation. Let $\pi(\gamma)$ generically denote their common expectation. For any given differentiation opportunity $\widehat{\gamma} \in [0, 1)$, we measure their incentive for product differentiation by the joint-profit gain they would derive from decreasing γ from 1 to $\widehat{\gamma}$:

$$\widehat{k}(\widehat{\gamma}) = 2\left[\pi(\widehat{\gamma}) - \pi(1)\right]. \tag{6}$$

To assess how vertical integration threats affect the downstream incentive for differentiation, we use the case of prohibitive integration costs (i.e., $E_p \geq S(0)$ in corollaries 1 and 2), whereby no integration threat can ever arise, as a benchmark.

[30] Where $S^C(\widetilde{\gamma}) = \underset{\gamma}{Min} S^C(\gamma)$.

A useful interpretation of this case is that of high expected legal costs induced by a strict antitrust policy towards vertical mergers. The benchmark incentive for differentiation,

$$\widehat{k}_p\left(\widehat{\gamma}\right) = 2\left[\pi_D(\widehat{\gamma}) - \pi_D(1)\right], \quad \widehat{\gamma} \in [0,1), \tag{7}$$

will just reflect the downstream firms' incentive to expand demand (*market size effect* of differentiation) and soften each other's symmetric competitive pressure (*market segmentation effect* of differentiation).

We start with the case of intense downstream competition. Recall that, with Bertrand competition, $\pi_D(1) = \pi_N(1) = 0$. The benchmark incentive (7) then reduces to:

$$\widehat{k}_p\left(\widehat{\gamma}\right) = 2\pi_D(\widehat{\gamma}), \; \widehat{\gamma} \in [0,1). \tag{8}$$

By corollary 2, any integration cost $E < E_p$ is associated with a critical value $\gamma_E \in (0,1)$ such that the integration threat is effective only for $\widehat{\gamma} < \gamma_E$ (see Figure 1*b*). This leads to the incentive for differentiation:

$$\widehat{k}_E\left(\widehat{\gamma}\right) = \begin{cases} 2\pi_N(\widehat{\gamma}) \text{ for } \widehat{\gamma} \in [0,\gamma_E) \\ 2\pi_D(\widehat{\gamma}) \text{ for } \widehat{\gamma} \in [\gamma_E,1]. \end{cases} \tag{9}$$

As $\pi_N(\widehat{\gamma}) < \pi_D(\widehat{\gamma})$ for any $\widehat{\gamma} \in [0,\gamma_E)$ (by A1.2), we immediately have:

Proposition 2. *When downstream competition is intense, a vertical integration threat always reduces the downstream firms' incentive for product differentiation.*

Proposition 2 is illustrated in Figure 2. The benchmark incentive for differentiation ($\widehat{k}_p$ in the Figure) follows the black solid line from $\gamma = 1$ to $\gamma = 0$. The incentive for differentiation with any non-prohibitive integration cost ($\widehat{k}_E$ in the Figure), is illustrated by the grey line. It equals the benchmark one as long as the integration threat is not effective ($\widehat{\gamma} > \gamma_E$), jumping downward and then lying below the benchmark incentive as the integration threat becomes effective ($\widehat{\gamma} \leq \gamma_E$).

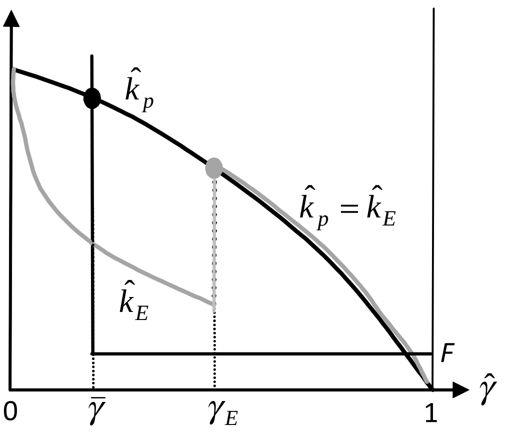

Figure 2

The interpretation of proposition 2 relies on the fact that, as intense downstream competition dampens the *business stealing value* of vertical integration, the upstream incentive to integrate monotonically increases with product differentiation and its value creation content. As a consequence, when the integration threat becomes effective, the strategic motive of preempting rent extraction *via* competition for integration unambiguously weakens the downstream firms' incentive for differentiation.

We turn now to the case of soft competition. Notice first that also with Cournot competition $\pi_N(1) = 0$ (as the integrated firm forecloses the market when products are perfect substitutes), but now $\pi_D(1) > 0$ (as profit margins are positive in a symmetric homogenous Cournot duopoly).

The benchmark incentive for differentiation is given by equation (7). All other cases of corollary 1 must be taken separately. With small integration costs, E_s, vertical integration will always occur, so that the incentive for differentiation becomes:

$$\widehat{k}_s(\widehat{\gamma}) = 2\pi_N(\widehat{\gamma}) \quad \text{for } \widehat{\gamma} \in [0, 1). \tag{10}$$

Any intermediate integration cost E_m is associated with two critical values of γ, $0 < \gamma_{m1} < \gamma_{m2} < 1$, such that the vertical integration threat is effective only for values of $\widehat{\gamma}$ lying outside the interval $[\gamma_{m1}, \gamma_{m2}]$ (as shown in Figure 1*a*). As integration (and market foreclosure) would occur at $\gamma = 1$, the incentive for differentiation becomes:

$$\widehat{k}_m(\widehat{\gamma}) = \begin{cases} 2\pi_N(\widehat{\gamma}) & \text{for } \widehat{\gamma} \in [0, \gamma_{m1}) \cup (\gamma_{m2}, 1) \\ 2\pi_D(\widehat{\gamma}) & \text{for } \widehat{\gamma} \in [\gamma_{m1}, \gamma_{m2}]. \end{cases} \tag{11}$$

Finally, any high integration cost E_h is associated with a critical value $\gamma_h \in (0, 1)$ such that the vertical integration threat is effective only for $\widehat{\gamma} < \gamma_h$ (see Figure 1*a*). Since now vertical integration (and foreclosure) would not occur for $\gamma = 1$, the incentive for differentiation is given by:

$$\widehat{k}_h(\widehat{\gamma}) = \begin{cases} 2[\pi_N(\widehat{\gamma}) - \pi_D(1)] & \text{for } \widehat{\gamma} \in [0, \gamma_h) \\ 2[\pi_D(\widehat{\gamma}) - \pi_D(1)] & \text{for } \widehat{\gamma} \in [\gamma_h, 1). \end{cases} \tag{12}$$

The next proposition shows that, when downstream competition is soft, a vertical integration threat may either weaken or strengthen the incentive for differentiation.

PROPOSITION 3. *If downstream competition is soft: i) with high integration costs, a vertical integration threat always reduces the downstream firms' incentive for product differentiation; ii) with intermediate integration costs, preempting integration strengthens the downstream firms' incentive to attain intermediate degrees of differentiation; iii) when integration can not be preempted because of small integration costs, vertical integration increases the downstream firms' incentive for differentiation unless the differentiation opportunities are small.*

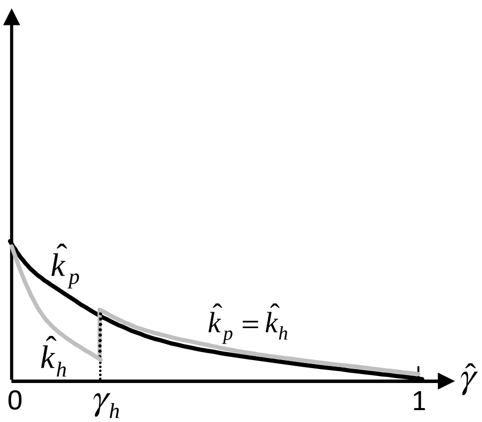

Figure 3

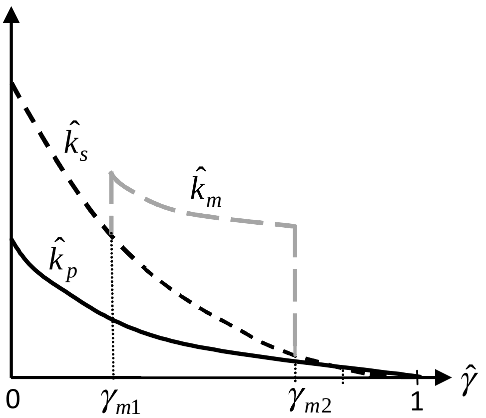

Figure 4

Part *i)* of proposition 3 is illustrated in Figure 3, parts *ii)* and *iii)* in Figure 4. In Figure 3, the incentive for differentiation with high integration costs, $\widehat{k}_h$ (the grey solid line), is contrasted with the benchmark incentive, $\widehat{k}_p$ (the black solid line). As in the case of intense competition depicted in Figure 2, $\widehat{k}_h$ equals the benchmark incentive as long as the integration threat is not effective ($\widehat{\gamma} > \gamma_h$); it jumps downward and then lies below the benchmark incentive as the integration threat becomes effective ($\widehat{\gamma} \leq \gamma_h$). Even if, with soft competition, the *business stealing value* of vertical integration is strong for weak differentiation, high integration costs neutralize its effect, so that the dominant force at work is still the first source of integration value, *double marginalization softening*, strengthened by product differentiation and its value creation content. Then, like in the case of intense competition, an effective threat of integration unambiguously reduces the downstream firms' incentive for differentiation.

Figure 4 compares the benchmark incentive, $\widehat{k}_p$ (the black solid line), with the incentive for differentiation when integration costs are intermediate, $\widehat{k}_m$ (the grey dash line), or small, $\widehat{k}_s$ (the black dash line). With intermediate integration costs, the *business stealing value* of vertical integration alters our previous preemption result. The integration threat now becomes effective either for strong ($\widehat{\gamma} < \gamma_{m1}$) or for weak ($\widehat{\gamma} > \gamma_{m2}$) degrees of differentiation. $\widehat{k}_m$ then equals $\widehat{k}_s$ (i.e., the incentive for differentiation when integration occurs notwithstanding differentiation) for differentiation opportunities outside the intermediate interval $[\gamma_{m1}, \gamma_{m2}]$, while it exceeds both $\widehat{k}_s$ and $\widehat{k}_p$ within the interval. Vertical integration preemption may now either strengthen or weaken the downstream incentive for differentiation.

Finally, with small integration costs vertical integration occurs for any degree of differentiation. The associated incentive for differentiation, $\widehat{k}_s$, is greater than the benchmark incentive, $\widehat{k}_p$, except when the differentiation opportunities are small. The intuition relies on the second strategic motive, we noticed from lemma 1, the *competition for integration channel* of rent extraction introduces in the downstream incentive for differentiation: sustaining the independent firm's profit, and hence the expected takeover price, if integration cannot be avoided. In this case, the incentive for differentiation is strengthened by the downstream firms' common interest to eliminate market foreclosure, reduce the integrated firm's incentive to raise the rival's cost, and soften the competitive pressure of a more efficient competitor, the integrated firm. These effects require that the differentiation opportunities are not so small to leave the independent firm's profit anyway negligible, in which case the benchmark incentive to soften each other's competitive pressure in the downstream market (under vertical separation) turns out to be stronger.

4.3. Vertical integration and welfare

Although product differentiation can cause anti-competitive market segmentation, social value creation can well be its prevailing welfare effect when innovative products, or simply better information on new or existing ones, are introduced. If so, our previous results immediately raise the concern that a prospective threat of vertical integration can impose a social cost in terms of less product differentiation, especially in innovative and competitive industries.

In our linear quadratic specification, the market size effect of differentiation is indeed strong enough to make the value creation effect of differentiation dominate its anti-competitive effect, and hence total market surplus (consumer surplus plus industry profits) increase with differentiation, in both vertical structures of the industry (separation and integration) and both modes of competition (Cournot and Bertrand).[31] Net welfare losses from vertical integration preemption *via* less differentiation (proposition 2 and first two parts of proposition 3) would then just require that the decrease in total market surplus due to less differentiation is not outweighed by any possible reduction in differentiation costs.

The easiest way to show this possibility is to assume $L-shaped$ differentiation costs, whereby any degree of differentiation up to a maximum value $1-\overline{\gamma}>0$ can be achieved at a fixed differentiation cost F. Consider the case of intense (Bertrand) competition depicted in Figure 2. As the differentiation incentive $\widehat{k}(\widehat{\gamma})$ is piecewise increasing in the differentiation opportunities, jumping downwards as the integration threat becomes effective ($\gamma=\gamma_E$), integration preemption will affect the optimal degree of differentiation only if $\overline{\gamma}$ is lower than (but not too far from) γ_E, and of course $F<\widehat{k}_p(\overline{\gamma})$. Because of the integration threat, the downstream firms would then select γ_E instead of $\overline{\gamma}$. Relative to the benchmark, society would suffer a reduction of total market surplus (due to less differentiation in the same vertical structure, separation) with no differentiation cost savings.

Of course, neither an actual preemptive reduction in product differentiation nor its effect on social welfare strictly depend on $L-shaped$ differentiation costs. The

[31] More precisely, as shown in appendix 2, total market surplus always increases with differentiation except in the case of small differentiation opportunities in Bertrand vertical separation equilibrium. In this case, intense competition magnifies the anti-competitive effect of a mild differentiation of homogeneous varieties, while the value creation effect of differentiation (market size effect) is still negligible.

argument above would similarly go through with variable differentiation costs, provided that the increase in the total differentiation cost between γ_E and $\overline{\gamma}$ is not too steep. Admittedly, for the downwards or upwards jumps in differentiation incentives caused by vertical integration threats to affect the actual degrees of differentiation, the role of variable differentiation costs in the firms' optimal differentiation choice must somehow be restricted. Nevertheless, cost structures biased towards fixed rather than (steep) variable costs do not seem implausible for activities like product design, development and launch, or publicity.[32]

With soft (Cournot) competition and intermediate integration costs, integration preemption may require to increase product differentiation relative to the benchmark (second part of proposition 3). Using a similar argument, social welfare would increase. It is however important to note that, also in the case of intermediate integration costs, vertical integration preemption would require less differentiation, and imply lower welfare, when the differentiation opportunities are strong. More generally, our results overall indicate that, irrespective of the mode of competition, less differentiation and lower welfare are the effects of vertical integration preemption when the differentiation opportunities, and hence their value creating potential, are strong.

Finally, vertical integration can never be preempted when competition is soft and integration costs are small, in which case the incentive for differentiation is generally stronger than the benchmark one (third part of proposition 3). To compare social welfare, notice first that, for any given degree of differentiation, total market surplus is greater in the vertically integrated equilibrium than in the vertically separated equilibrium.[33] To this gain (arising from the social benefit of less double marginalization in the industry), on the benefits side of the small integration costs case we must add the increase in total market surplus due to more differentiation. On the costs side, we need to account for the integration cost and any additional differentiation costs. We prove in appendix 2 that the overall effect on social welfare is always positive.

5. ROBUSTNESS AND EXTENSIONS

5.1. Mere market segmentation

Matsushima (2009) argues that vertical integration may cause a welfare loss in terms of anti-competitive market segmentation. In this section, we show that anti-competitive market segmentation is also the net welfare effect of vertical integration preemption in our model, once we eliminate the value creation content of product differentiation, and hence its market size effect.[34] Contrasting this with our previous

[32] These activities typically generate substantial initial costs (e.g., R&D, marketing and publicity strategic consultancy) to identify the alternative options. These costs are to a large extent fixed relative to the more or less ambitious targets of the different options, the implementation of which would then carry different (i.e., variable, in our sense) costs. See, e.g., Trott (2008).

[33] As shown in appendix 2, this holds under both modes of competition.

[34] As discussed in section 6, the channels through which vertical integration affects product differentiation in Matsushima and in our model are however very different.

results, one can argue that while vertical integration should raise concerns of under-investment in socially valuable differentiation activities in innovative industries, where the value creation content of product differentiation is likely to be strong, it should raise concerns of anti-competitve market segmentation in mature industries, where the value creation content of product differentiation is probably more limited.

Following previous literature, we eliminate the market size effect of differentiation by adopting the following version of linear-quadratic preferences: [35]

$$U = a(q_1 + q_2) - \frac{1}{2}[(2-\gamma)\left(q_1^2 + q_2^2\right) + 2\gamma q_1 q_2] + m,$$

which yields the inverse demand system:

$$p_i = a - (2-\gamma)\, q_i - \gamma q_j \quad (i, j = 1, 2;\ i \neq j).$$

For given quantities, the direct effect of γ on utility and demand prices does not show anymore value and demand creation through differentiation. This leaves differentiation just carrying market segmentation.[36]

In appendix 2, we first show that Assumption 1 still holds in Cournot vertical separation and vertical integration equilibria under the new specification of preferences. We next prove that, in the new specification, the gross surplus from integration, $S^c(\gamma)$, is strictly positive and monotonically increasing in γ (i.e., monotonically decreasing with product differentiation). Consistently with our previous interpretation of the $U-shaped$ pattern of the integration surplus under Cournot competition and standard preferences, removing the market size effect of differentiation weakens the *double marginalization softening* source of surplus, that is, the source of surplus positively affected by product differentiation; the shape of the surplus will then just mirror the strength of the *business stealing* source, monotonically increasing in γ (decreasing with differentiation).

Next, from lemma 1 and the shape of the gross surplus from integration, we distinguish three crucial classes of integration costs: *prohibitive*, still our benchmark case (now identified by $E_p \geq S^c(1)$), whereby no integration threat can ever occur; *intermediate or high*, $E_c \in [S^c(0),\ S^c(1))$, whereby each integration cost level identifies a critical value of product substitutability, $\gamma_c(E_c) \in [0, 1)$, such that the integration threat is effective only for $\gamma > \gamma_c(E_c)$ (i.e., for sufficiently low degrees of differentiation); *small*, defined now by $E_s < S^c(0)$, whereby vertical integration always occurs.

As $\pi_N(1) = 0$ and $\pi_D(1) > 0$ (for the same reasons explained in the previous

[35] Originally proposed by Shubik and Levitan (1980), this version has been used, among others, by De Fraja and Norman (1993), Martin (2002), Motta (2004), Calzolari and Denicoló (2013).

[36] See appendix 2 for a more detailed discussion on the way this version eliminates the consumer's preference for differentiation, and hence the market size effect, which characterize the standard linear-quadratic specification of preferences.

section), the incentive for differentiation in the three cases is:

$$\widehat{k}_p(\widehat{\gamma}) \equiv 2\left[\pi_D^c(\widehat{\gamma}) - \pi_D^c(1)\right], \ \forall \widehat{\gamma} \in [0,1],$$

$$\widehat{k}_c(\widehat{\gamma}) = \begin{cases} 2\pi_D^c(\widehat{\gamma}), \ \widehat{\gamma} \in [0, \gamma_c(E_c)] \\ 2\pi_N^c, \ \widehat{\gamma} \in (\gamma_c(E_c), 1] \end{cases},$$

$$\widehat{k}_s(\widehat{\gamma}) = 2\pi_N^c(\widehat{\gamma}), \ \forall \widehat{\gamma} \in [0,1].$$

Preempting integration by strategically altering product differentiation is possible only with *intermediate or high* integration costs, and it would always require to choose degrees of differentiation higher than a critical level $1 - \gamma_c(E_c)$. As, by inspection, $\widehat{k}_c(\widehat{\gamma})$ exceeds $\widehat{k}_p(\widehat{\gamma})$ over the entire interval $\widehat{\gamma} \in [0, \gamma_c(E_c)]$, we can conclude that vertical integration preemption always incentivizes firms to increase product differentiation in this specification of the model. As for the welfare consequences of this effect, we show in appendix 2 that, by carrying anti-competitive market segmentation with no additional value to consumers, stronger differentiation always reduces total market surplus in this specification, irrespective of the vertical structure of the industry. Thus, even disregarding any possible extra differentiation cost, vertical integration preemption always reduces social welfare.[37]

5.2. Non-cooperative differentiation

In this section, we account for the role horizontal differentiation spillovers would play at the differentiation stage, should the downstream firms take their differentiation decision competitively. More precisely, we substantiate our initial claim that, albeit important, this role is to a large extent orthogonal to the effect of a vertical integration threat on product differentiation.

Lambertini and Rossini (1998) consider a simultaneous differentiation game as a pre-stage of a standard linear quadratic differentiated duopoly. We adopt their game here as the differentiation stage of our model. Each downstream firm must simultaneously decide whether to pay or not a fixed differentiation cost F. If no firm invests, products remain perfect substitutes ($\gamma = 1$). If only one firm invests, product substitutability reduces to $\widehat{\gamma}_1 \in (0,1)$. If both firms invest, product substitutability further drops to $\widehat{\gamma}_2 \in (0, \widehat{\gamma}_1)$. Payoffs are determined by the differentiation cost, F, and the symmetric profit expectations of the downstream firms at the differentiation stage, $\pi(\gamma)$, derived in section 4.2. The game is therefore symmetric, as in Lambertini and Rossini.

Differentiation spillovers clearly set the main strategic incentive in this game: free riding on the opponent's investment in differentiation.[38] This strategic in-

[37] In appendix 2 we also show that $\widehat{k}_s(\widehat{\gamma}) > \widehat{k}_p(\widehat{\gamma})$ except when the differentiation opportunities are very small (i.e, $\widehat{\gamma}$ is very close to one). That is, unavoidable vertical integration (under small integration costs) generally strengthens the incentive for differentiation relative to the benchmark case where vertical integration can never occur. The welfare comparison of these two cases interestingly reveals that, notwithstanding the social benefit of reducing double marginalization, vertically integration can still cause a net reduction in social welfare due to anti-competitive segmentation of the downstream market.

[38] Indeed, Lambertini and Rossini focus on the zero-investment prisoner dilemma equilibrium which arises in this game if $\pi(\widehat{\gamma}_2) - \pi(\widehat{\gamma}_1) < F$ and $\pi(\widehat{\gamma}_1) - \pi(1) < F$, while $\pi(\widehat{\gamma}_2) - \pi(1) > F$.

centive would enter our model and combine with the incentive of preempting or softening downstream rent extraction by means of weaker or stronger differentiation, complicating the analysis. Our point here is that this complication would not help gaining much insight on the effect of a vertical integration threat on product differentiation.

To illustrate, consider our integration preemption result *via* less differentiation in proposition 2. Suppose that $\widehat{\gamma}_1$ in the current extension equals the critical value γ_E in the proposition, so that each downstream firm's expected profit gain if only one of them invests is pinned down by the grey point marked on the grey line in Figure 2.[39] Furthermore, each firm's expected profit gain associated with two simultaneous investments, leading to $\widehat{\gamma}_2 < \gamma_E$, will end up in the dip of the grey line. To fix ideas, let $\widehat{\gamma}_2$ equal $\overline{\gamma}$ in the Figure. Assume, finally, that, in the benchmark case (i.e., along the black line in the Figure), $\pi_D(\widehat{\gamma}_2) - \pi_D(\widehat{\gamma}_1) > F$ and $\pi_D(\widehat{\gamma}_1) - \pi_D(1) > F$, so that (as it can be easily verified) both firms would invest in equilibrium in the absence of integration threats.

Under the integration threat, the drop in profit expectation at $\widehat{\gamma}_2$ will generate now an expected profit loss associated with an additional investment in differentiation, $\pi_N(\widehat{\gamma}_2) - \pi_D(\widehat{\gamma}_1) < 0$, whereas the expected profit gain associated with a single investment would still be given by $\pi_D(\widehat{\gamma}_1) - \pi_D(1) > F$. As it can be easily verified, the solution of the integration game would now give us two equilibria where only one firm invests. In other words, competition in product differentiation would just give the same result illustrated in Figure 2: because of the vertical integration threat, product differentiation would be limited to γ_E instead of leading to the lower degree of substitutability $\overline{\gamma}$.

More generally, despite the new strategic motives introduced by non-cooperative differentiation, a jump (upwards or downwards) in the expected profit due to an integration threat would generally affect the equilibrium outcome of the differentiation game in the same direction already captured by our cooperative measure of the differentiation incentive.

5.3. Upstream competition

At a first glance, upstream market competition would seem to weaken the *competition for integration channel* of downstream rent extraction, as a separated downstream firm would depend less on any vertically integrated firm for the provision of input, and the upstream firms might now end up playing against each other for vertical integration. In this extension we show, on the contrary, not only that this channel of downstream rent extraction is robust to the presence of upstream competition if, as intuition suggests, the upstream firms have sufficiently strong

[39] A clarification on our use of Figure 2 here is in order. Strictly speaking, the grey and black lines in the Figure represent the downstream firms' *joint profit gain* from differentiation (under non-prohibitive and prohibitive integration costs, respectively). Here we are using them to represent each *individual firm's profit gain* as arising from the simultaneous differentiation decisions of the two firms. As any individual firm's profit gain is just half of the joint profit gain, the shape of the former (as a function of the degree of differentiation), which is what matters here, is exactly the same as the shape of the latter. The two lines can therefore be equally used to represent qualitatively each individual firm's profit gain in the differentiation game.

bargaining power at the integration stage (*first claim*). But also that its effects can be magnified by competition for integration being played by vertical pairs of firms, which can cause over-investment in integration and rent dissipation. As a consequence, both downstream firms may strictly prefer full vertical separation in the industry (that is, they would still perceive vertical integration as a threat - of rent dissipation now - at the differentiation stage) even if they would enjoy full bargaining power at the integration stage (*second claim*). Furthermore, it is even possible that although all (upstream and downstream) firms would strictly prefer full vertical separation, they end up in a prisoner dilemma equilibrium where they are all (pairwise) vertically integrated (*third claim*).

In this extended setting, we have two upstream firms, U_1 and U_2, and two downstream firms, D_1 and D_2. To simplify matters, we assume that any vertically integrated firm will just transfer the input at zero internal price to its downstream division. Three vertical structures of the industry are possible. Full vertical separation (indexed by SS), where all firms are independent and Cournot competition takes place both in the upstream and in the downstream markets (fully separated successive Cournot duopoly). Partial integration (PI), where only one vertical pair, say U_1 and D_1, is integrated, and engaged in Cournot competition with D_2, in the downstream market, and with U_2, for the provision of input to D_2, in the upstream market (partially integrated successive Cournot duopoly). Full pairwise integration (FI), where both pairs are integrated and engaged in Cournot competition in the downstream market (fully integrated Cournot duopoly).

As in Matsushima (2009), the integration stage is modelled as a simultaneous game played by predetermined vertical pairs (one upstream and one downstream firm in each pair). The strategy set of each pair just comprises the decision to merge, v, or to remain separated, s. Before choosing their strategy, the firms in each pair commit to split any expected net surplus from integration arising as a consequence of their decision according to the downstream bargaining power parameter $\delta \in [0, 1]$. The expected net surpluses from partial integration, $S_{PI} - E$, and from full integration, $S_{FI} - E$, must be in line with a consistent conjecture on the strategy chosen by the rival pair: separation, s, for the net surplus from partial integration; integration, v, for the net surplus from full integration. Thus:

$$
\begin{aligned}
S_{PI} - E &= \Pi_I^{PI} - \left[\pi_U^{SS} + \pi_D^{SS}\right] - E \\
S_{FI} - E &= \Pi_I^{FI} - \left[\pi_U^{PI} + \pi_D^{PI}\right] - E.
\end{aligned}
\tag{13}
$$

In (13), Π_I^{PI} and Π_I^{FI} are the equilibrium profits of an integrated firm under partial and under full integration; π_U^{SS} and π_D^{SS} the profits of both upstream and both downstream firms under full separation; π_U^{PI} and π_D^{PI} those of the separated upstream and the separated downstream firms under partial integration. These profits and the integration cost E immediately determine the payoff matrix of the integration game shown in appendix 1.[40] Assume finally that, if the anticipated

[40] The equilibrium profits and all analytical results are derived in appendix 2. The solution of the integration game is characterized in terms of the sign combinations of the two net surpluses from

equilibrium outcome of the integration game is partial integration, each pair ex-ante expects to be the merging one with probability one-half.

Firms' expected profits before the integration stage (and hence, from the downstream firms viewpoint, at the differentiation stage) will be:

$$\begin{aligned} \pi_{D_e}^{PI} &= \tfrac{1}{2}\left(\pi_D^{PI}\right) + \tfrac{1}{2}[\pi_D^{SS} + \delta\left(S_{PI} - E\right)] \\ \pi_{U_e}^{PI} &= \tfrac{1}{2}\left(\pi_U^{PI}\right) + \tfrac{1}{2}\left[\pi_U^{SS} + (1-\delta)\left(S_{PI} - E\right)\right], \end{aligned} \tag{14}$$

if the anticipated outcome is *partial integration*;

$$\begin{aligned} \pi_{D_e}^{FI} &= \pi_D^{PI} + \delta\left(S_{FI} - E\right) \\ \pi_{U_e}^{FI} &= \pi_U^{PI} + (1-\delta)\left(S_{FI} - E\right), \end{aligned} \tag{15}$$

if the anticipated outcome is *full integration*;

$$\begin{aligned} \pi_{D_e}^{SS} &= \pi_D^{SS} \\ \pi_{U_e}^{SS} &= \pi_U^{SS}, \end{aligned}$$

if the anticipated outcome is *full separation*.

The following profit inequalities, proved in appendix 2 for any $\gamma \in (0,1)$, are crucial for our three claims: [41]

$$\pi_D^{SS} > \pi_D^{PI}, \qquad \pi_U^{SS} > \pi_U^{PI}, \qquad \Pi_I^{PI} > \Pi_I^{FI}. \tag{16}$$

Consider first partial integration as the expected equilibrium outcome. Although it requires $S_{PI} - E > 0$ (see footnote 40), the first inequality in (16), $\pi_D^{SS} > \pi_D^{PI}$, immediately implies that, for sufficiently small values of δ, the downstream firms' expected profit $\pi_{D_e}^{PI}$ in (14) falls short $\pi_{D_e}^{SS}$, which is our *first claim*. The same argument applies when full integration is the expected outcome, which requires $S_{FI} - E > 0$: again the first inequality in (16) assures that $\pi_{D_e}^{FI} < \pi_{D_e}^{SS}$ when δ is small enough.

To prove our other two *claims*, notice first that inequalities (16) allow any of the two surpluses from integration in (13) to be greater than the other. More precisely, as shown in appendix 2, the ranking of the gross surpluses, S_{FI} and S_{PI}, reverses only once in the range $\gamma \in (0,1)$, and shows higher values for S_{FI}

integration. The game admits: 1) the unique full integration equilibrium (v,v), if $S_{FI} - E > 0$, $S_{PI} - E > 0$; 2) the two partial integration equilibria (v,s) and (s,v), if $S_{FI} - E < 0$, $S_{PI} - E > 0$; 3) the unique full separation equilibrium (s,s), if $S_{FI} - E < 0$, $S_{PI} - E < 0$; 4) the two equilibria (v,v) and (s,s), if $S_{FI} - E > 0$, $S_{PI} - E < 0$. All sign combinations of the two surpluses turn out to be possible for different degrees of product differentiation and integration cost levels.

[41] Their interpretation is simple. Partial vertical integration allows the integrated firm to foreclose part of the upstream rival's market, and compete with it on equal ground for the provision of input to the separated downstream firm. The latter is left in the position of a high cost competitor in the downstream market, losing market share and profits at the advantage of the downstream division of the integrated firm (which is provided with the essential input at zero internal price). Both (upstream and downstream) separated firms are therefore worse off under partial integration than under full separation. Furthermore, the resulting overall profits of the integrated firm under partial integration always exceeds those of an integrated firm under full integration, as the latter is constrained by the tougher competitive pressure of a symmetric, equally efficient, integrated competitor.

when differentiation is sufficiently strong (low values of γ). Then, with sufficiently strong differentiation and high integration costs, we can have full integration with arbitrarily small values of the net surplus $S_{FI} - E$. In this case, the first inequality in (16), $\pi_D^{SS} > \pi_D^{PI}$, implies now $\pi_{D_e}^{FI} < \pi_{D_e}^{SS}$ for any $\delta \in [0, 1]$. That is, our *second claim*: both downstream firms may perceive full integration as a threat (of rent dissipation now) even if they would enjoy full bargaining power at the integration stage. In appendix 2, we finally prove our *third claim*: in the same parameter region (i.e., for high values of E and low values of γ), full integration can arise as the unique equilibrium of the integration game, whilst all firms would be strictly better off under full separation. Interestingly, as in our baseline model with strong differentiation opportunities and any mode of downstream competition, vertical integration preemption would again require less product differentiation.

6. RELATED LITERATURE

Interesting contributions in the recent literature have considered the effects of vertical relations on process and product innovations. Stefanidis (1997) shows that upstream firms may use exclusive dealings to disincentivize rivals' investment in process innovations. In Banarjee and Lin (2003), downstream firms' process innovation is fostered by a *raising the rival cost effect.* Brocas (2003) and Buehler and Shmutzler (2008) analyze endogenous vertical integration and process innovations. In Brocas (2003) upstream firms' innovations (licensed to downstream firms) and vertical integration mutually reinforce when switching to alternative technologies is not too costly. Buehler and Schmutzler (2008) unveils an *intimidation effect* which strengthens a vertically integrated firm's incentive to invest in downstream innovations, showing that full vertical separation becomes less likely. Chen and Sappington (2010) studies the combined effect of vertical integration and downstream competition (i.e., Bertrand v. Cournot competition) on an upstream monopolist's incentive to invest in process innovations. Economides (1999) shows that vertical integration can improve overall product quality in a successive monopoly model with endogenous (upstream and downstream) quality choices. Milliou (2004), Miliou and Petrakis (2011) and Allain et al. (2011), study the effects of informational spillovers potentially conveyed by vertically integrated firms on downstream innovation.

Recent empirical and theoretical studies focus on the effects firms' innovation activities, in turn, exert on vertical relations. Ulrich and Ellison (2005) provide interesting empirical evidence of the impact of product design on the vertical organization of production in the U.S. mountain bicycle industry. Still on the empirical side, Fresard et al. (2016) find that firms in high R&D industries are overall less likely to vertically integrate, arguing this would arise from an incentive to retain flexibility and residual right of control on intangible assets to finalize innovations. A similar argument has recently been advanced, in the managerial and contract law literatures, to explain the high level of vertical disintegration and R&D outsourcing observed in high-tech industries relative to what the standard hold-up theory of vertical integration would suggest: independent developers of technological modules would be better able to diversify research and thereby circumvent dried technological lines (Chesbrough, 2004; Gilson et al., 2008).[42] On the theoretical side, Liu (2016) explains the coexistence of vertically integrated and vertically separated firms in innovative industries by modelling a stronger incentive to integrate when upstream and downstream innovations are both important along the value creation line. Relative to these studies, we show that, besides flexibility or vertical complementarities in innovation activities, a threat of rent extraction via competition for vertical integration, linked to horizontal spillovers in innovation activities like product design, market positioning, and informative advertisement, can affect the attitude of innovative firms towards vertical mergers, with concerning effects on innovation and social welfare.

Several works have analyzed the effects of (exogenous) horizontal product differentiation on the incentives for vertical integration and foreclosure (e.g. Ordover, Saloner and Salop, 1990, Colangelo, 1995, Hackner, 2001, Chen, 2001, Economides, 2004), stressing the countervailing effect on vertical foreclosure. A related literature focuses on the relationship between input specialization and downstream product differentiation under alternative vertical structures (Choi and Yi, 2000, Pepall and Norman, 2001, Belleflamme and Toulemonde, 2003). Matsushima (2009) is the paper closest to ours in this literature. In a successive differentiated duopoly *à la* Hotelling (where upstream market transportation costs stand for input conversion costs), it shows that vertical integration can fix the downstream firms' hold up problem of strengthening, through differentiation, the bargaining power of specialized suppliers, but the net effect on social welfare may be negative because of anti-competitive segmentation of the downstream market. Our main finding in the *mere market segmentation* extension of our model (section 5.1), that the competition for integration threat can impose on society a net welfare cost in terms of anti-competitive market segmentation, closely relates to Matsushima's result, although vertical integration plays quite a different role in our setting. We also relate to Matsushima (2009) for the way we model the integration game in the *upstream competition* extension (section 5.3).

We are in line with the traditional hold-up theory of vertical integration in assuming that firms may fail in fixing inefficiencies by themselves because of a lack of commitment power, in our case to refrain from triggering competition for integration (on the upstream side) and to compete for integration (on the downstream side). However, the asset-specific investments of the traditional theory and our investment activities lie at opposite extremes on a crucial dimension. While the former generate exclusive value for individual, specific, relationships, the latter spill over potential value for a set of alternative relationships. Vertical integration

[42] The view that independent innovators and start-up companies carry important flexibility advantages which may be lost by excessive industry consolidation is frequently reported by operators and specialized commentators of high-tech industries. See, for instance, "*Pre-integrated and packaged solutions deliver simplification but could threaten innovation*" in Global Telecom Business CIO and CFO Guide to OSS/BSS: March/April 2011.

then fixes the hold-up problem and recovers investment efficiency in the standard theory, but creates investment inefficiencies in our model. Interestingly, Allain et al. (2016) show that, by inducing hold-up problems in the vertical relationships of competitors, vertical integration can be the cause of, rather than the therapy for, investment inefficiencies also in the standard theory.

Finally, the dampening effect of intense downstream competition (i.e., Bertrand instead of Cournot competition) on an integrated firm's incentive to foreclose a downstream rival, discussed in section 4.2, parallels an interesting argument recently advanced by Chen (2016) to question the theoretical rationale of *price squeezing* (i.e., market foreclosure through rival's cost raising) as an exclusionary practice. Instead of foreclosing the market to enforce an high-cost monopoly, Chen's argument goes, a vertically integrated firm would better relocate final production to a more efficient downstream rival, and thereby reap at least part of the consequent efficiency gain as upstream profits (*via* its input sales to the rival). A similar incentive is at work in our case, but arising now from mild product differentiation and intense downstream market competition rather than cost asymmetries. Instead of foreclosing the market to enforce an homogeneous monopoly (*via* a large gap between the external and the internal input prices), an integrated firm would better leave a slightly differentiated downstream competitor active in the market, and thereby extract at least part of consumers' gain from variety as upstream profits (*via* high, internal and external, input prices).

7. DISCUSSION AND CONCLUSIONS

The central message of our paper is that new profit opportunities created by independent developers of innovative products may attract aggressive upstream takeovers which can negatively impact the developers' incentives to innovate. Lack of commitment to resist aggressive takeovers (i.e., to refrain from engaging in *competition for integration*), on the one hand, and the expectation of tougher competitive pressure in the product market by an integrated firm, on the other hand, can incentivize these independent innovators to set their product characteristics in such a way to preempt (or soften) the rent extraction associated with the takeovers, even at the cost of foregoing profitable and valuable innovation opportunities.

Documenting preemption is of course problematic. Exogenous changes in antitrust or corporation law could in principle be used to gain indirect evidence of it, although any associated change in firms' innovation and differentiation activities would likely mix different effects, probably difficult to disentangle.[43] At any rate, our findings would offer the empirical work a main testable prediction: higher (vertical) takeover risk, as possibly associated with a more permissive legal framework, would negatively affect independent firms' product differentiation and innovation activities in innovative and competitive industries.

[43] For instance, stricter anti-takeover rules would also affect managerial incentives, and the direction of this effect is still an open question in the agency cost literature on corporate governance.

If our message is broadly consistent with a concern, reported from different literatures, high-tech operators and specialized commentators, that vertical mergers and consolidation in high-tech sectors may waste a range of beneficial effects guaranteed by independent developers, more focused evidence of its relevance can be inferred from emblematic examples.

Consider first a *soft-innovation industry* case, iconic in the US legal debate on corporate social responsibility: the *Unilever*'s takeover of *Ben and Jerry's Ice Cream*. The innovation component in this story is *Ben and Jerry's* pioneering a new product, an eco-friendly socially responsible ice cream brand initially niched in the hippy culture of the early 70s. The April 2000 acquisition by *Unilever* (one of the largest consumer good multinationals, intensively resorting to merger and acquisition strategies in a range of sectors, ice cream included) apparently took place despite the contrariety of the *Ben and Jerry's* founders and managers, concerned of a likely negative impact of the acquisition on the distinctive characteristics of their brand and company (arguably valued by certain types of consumers). The most interesting point for us arises from the corporate law debate opened by this case, where the legal obligation for a public company to accept the best takeover offer to insure shareholders' wealth maximization has been advocated as the reason for the final "forced" decision of the founders-managers to sell, as well as a possible disincentive to create value through *social innovations* (Page and Katz, 2012). In the debate, the development of alternative corporate forms has been suggested in order to strengthen the commitment to resist aggressive takeovers and recover incentives.[44]

The second case is from the *innovation-intensive sector* of video games development. Commenting the recent attempts of *Vivendi SA* (a multinational mass media conglomerate) to take over *Ubisoft* (a publishing and development powerhouse), *Ubisoft* Vice President of live operations, Anne Blondel-Jouin, stressed the relationship between the company independence and its innovative potential in the following terms: "*What made us so successful for 30 years is being super independent, being very autonomous [...]. This is what we want to remain, it's what has made us successful and been able to deliver the type of games we've been delivering [...]*".[45] If this concern clearly refers to the expected negative effect of a successful takeover, the key role independence seems to play in the innovation culture of this company suggests that its innovation and marketing strategies could well be affected by a persistent risk of takeovers. Furthermore, the incentive to start-up and develop innovative companies with a similar culture would likely be undermined by an industry environment characterized by high and persistent takeover risks.

We have abstracted from too many possible sources of social costs and benefits, well scrutinized in the vast literature on vertical integration, to derive anything

[44] Since 2008, alternative corporate forms, such as *low-profit limited liability companies*, *benefit corporations*, and *flexible purpose corporations*, have actually been designed and introduced in several US states to better fit *social enterprises*.

[45] Interview of Anne Blondel-Jouin with *PCgamesN*, 24 November 2016: http://www.pcgamesn.com/ubisoft-vivendi-takeover-bid

but tentative antitrust policy implications from our results. A possible one is that in differentiated competitive industries vertical foreclosure strategies tend to be less important, so that focusing on pre- and post- merger indicators of market concentration and dominance in the affected markets may not be crucial. On the contrary, it is in these industries that, according to our results, an upstream threat of rent extraction *via* competition for integration is more likely to arise and to hinder socially valuable differentiation. Of course, if preempted, a merger will never end up under the scrutiny of the authorities. However, paying attention to possible indicators of rent extraction through this channel in the examined cases, such as the takeover price and the recent history of alternative offers to or from other firms, may increase its expected legal costs and therefore reduce the possible social costs associated with its preemption.

REFERENCES

[1] Alfaro, L., Paola C., Fadinger H. and A. Newman, 2016, Do prices determine vertical integration?, *Review of Economic Studies*, 83, 855-880.

[2] Allain, M. L., C. Chambolle and P. Rey, 2016, Vertical integration as a source of hold-up, *Review of Economic Studies*, 83, 1-25.

[3] Allain, M. L., C. Chambolle and P. Rey, 2011, Vertical integration, information and foreclosure", *IDEI Working Paper*, N. 673.

[4] Arya, A., B. Mittendorf and D. E. M. Sappington, 2008, Outsourcing, Vertical integration, and price vs. quantity competition, *International Journal of Industrial Organization*, 26, 1-16.

[5] Bowley, A. L., 1924, *The mathematical groundwork of economics*, Oxford University Press, Oxford.

[6] Buehler, S. and A. Schmutzler, 2008, Intimidating competitors - Endogenous vertical integration and downstream investment in successive oligopoly, *International Journal of Industrial Organization*, 26, 247-265.

[7] Belleflamme, P. and E. Toulemonde, 2003, Product differentiation in successive vertical oligopolies, *Canadian Journal of Economics*, 36, 523-545.

[8] Banarjee, S. and P. Lin, 2003, Downstream R&D, raising rivals' costs, and input price contracts, *International Journal of Industrial Organization*, 21, 79-96.

[9] Brocas, I., 2003, Vertical Integration and the incentive to innovate, *International Journal of Industrial Organization*, 21, 457-488.

[10] Calzolari, G. and V. Denicoló, 2013, Competition with exclusive contracts and market-share discounts, *American Economic Review*, 103, 2384-2411.

[11] Chen, Y., 2001, On vertical mergers and their competitive effects, *RAND Journal of Economics*, 32, 667 - 685.

[12] Chen, Z., 2016, Vertical integration and rent extraction, mimeo.

[13] Chesbrough, H., 2005, Towards a Dynamics of Modularity: A Cyclical Model of Technical Advance, in Prencipe, A„ Davies, A. and M. Hobday (eds.), *The Business of Systems Integration,* Oxford Scholarship Online.

[14] Chen, Y. and D. E. M. Sappington, 2010, Innovation in Vertically Related Markets, *Journal of Industrial Economics*, 58, 373-401.

[15] Choi, J. P., and S. S. Yi, 2000, Vertical foreclosure with the choice of input specifications, *RAND Journal of Economics*, 31, 717-743.

[16] Colangelo, G., 1995, Vertical vs. horizontal integration: preemptive merging, *Journal of Industrial Economics*, 48, 323-337.

[17] De Fraja, G. and G. Norman, 1993, Product differentiation, pricing policy and equilibrium, *Journal of Regional Science*, 33, 343-363.

[18] Dixit, A., 1979, A model of duopoly suggesting a theory of entry barriers, *Bell Journal of Economics*, 10, 20-32.

[19] Economides, N., 1999, Quality choice and vertical integration, *International Journal of Industrial Organization*, 17, 903 - 914.

[20] Economides, N., 2004, The incentive for vertical integration, Stern School of Business, New York University, *Working Paper* EC-94-05.

[21] EU Guidelines on the assessment of non-horizontal mergers under the Council Regulation on the control of concentrations between undertakings, *Official Journal of the European Union*, 2008/C, 265/07.

[22] Fresard, L., Hoberg G. and G. Phillips, 2016, Innovations activities and the incentives for vertical acquisition and integration, mimeo.

[23] Gilson, R., Sabel C. and R. Scott, 2008, Contracting for innovation: vertical disintegration and interfirm collaboration, European Corporate Governance Institute, *Law Working Paper* N. 118/2008.

[24] Hackner, J., 2003, Vertical integration and competition policy, *Journal of Regulatory Economics*, 24, 213-222.

[25] Hart, O. and J. Tirole, 1990, Vertical integration and market foreclosure, *Brookings Papers on Economic Activity* (Special Issue), 205 - 276, and 285-286.

[26] Lambertini, L. and G. Rossini, 1998, Product homogeneity as a prisoner's dilemma in a duopoly with R&D, *Economics Letters*, 58, 297 - 301.#

[27] Liu, X., 2016, Vertical integration od innovation, *International Journal of Industrial Organization*, 47, 88-120.

[28] Martin, S., 2002, *Advanced industrial economics*, Blackwell, Oxford (2nd edition).

[29] Matsushima, N., 2009, Vertical mergers and product differentiation, *Journal of Industrial Economics*, 57, 812-834.

[30] Milliou, C., 2004, Vertical integration and R&D information flow: is there a need for 'firewalls'?, *International Journal of Industrial Organization*, 22, 25-43.

[31] Motta, M., 2004, *Competition Policy*, Cambridge University Press, NY.

[32] Milliou, C. and E. Petrakis, 2012, Vertical integration, knowledge disclosure, and decreasing rival's cost, Universidad Carlos III de Madrid, *Working paper* 12-13.

[33] Ordover, J.A., G. Saloner and S. C. Salop, 1990, Equilibrium vertical foreclosure, *American Economic Review*, 80, 127-142.

[34] Page, A., and R. Katz, 2012, The truth about Ben & Jerry's bio-footer, *Sanford Social Innovation Review*, Fall 2012.

[35] Pepall, L. and G. Norman, 2001, Product differentiation and upstream-downstream relations, J*ournal of Economics and Management Strategy*, 10, 201-233.

[36] Rey, P. and J. Tirole, 2007, *A premier on foreclosure*, in M. Armstrong and R. H. Porter (eds.), Handbook of Industrial Organization, Vol. 3, North-Holland, Amsterdam.

[37] Riordan, M. H., 1998, Anticompetitive vertical integration by a dominant firm, *American Economic Review*, 88, 1232-1248.

[38] Riordan, M. H., 2008, C*ompetitive effects of vertical integration*, in P. Buccirossi (ed.), Handbook of Antitrust Economics, MIT Press.

[39] Riordan, M. H. and Y. Chen, 2007, Vertical integration, exclusive dealing, and ex post cartelization, *RAND Journal of Economics*, 31, 1-21.

[40] Riordan, M. H. and S. C. Salop, 1995, Evaluating vertical mergers: a post-Chicago approach, *Antitrust Law Journal*, 63, 513-68.

[41] Roberts, D. J., 2009, *Mergers & Acquisitions: an insider's guide to the purchase and sale of Middle Market business interests*, John Wiley & Sons, New Jersey.

[42] Salinger, M., 1988, Vertical mergers and market foreclosure, *Quarterly Journal of Economics*, 103, 345-356.

[43] Salop, S. C. and D. T. Scheffman, 1983, Raising rivals' costs, *American Economic Review*, AEA Papers and Proceedings, 73, 267-271.

[44] Shubik, M., and R. Levitan, 1980, *Market structure and behavior*, Cambridge, MA: Harvard University Press.

[45] Singh, N. and X. Vives, 1984, Price and quantity competition in a differentiated oligopoly, *RAND Journal of Economics*, 15, 546-554.

[46] Spence, A. M., 1976, Product differentiation and welfare, *American Economic Review*, 66, 407-414.

[47] Stefanidis, C., 1997, Downstream vertical foreclosure and upstream innovation, *Journal of Industrial Economics*, 45, 445-456.

[48] Sunshine, S. C., 1994, *Initiatives in merger and joint venture analysis*, U.S. Department of Justice (Address by the Deputy Assistant Attorney, General Antitrust Division, before the 33th Antitrust Conference in New York, March 3, 1994).

[49] Trott, P., 2008, *Innovation Management and New Product Development*, Prentice Hall.

[50] Ulrich, K. T. and D. J. Ellison, 2005, Beyond make-buy: internalization and integration of design and production, *Production and Operations Management*, 14, 315-330.

[51] Varney, C. A., 1995, *Vertical merger enforcement challenges at the FTC*, PLI 36th Annual Antitrust Institute San Francisco, California.

Appendix 1

Proof of lemma 1. (We drop all functional notations as they are irrelevant for the proof). Notice preliminary that any offer $P > \pi_D + (S - E)$ would be rejected by firm U, as its payoff (equation (8)) would be negative.

Condition (2) implies $\pi_D < \pi_D + (S - E)$. In this case, any downstream firm D_i will find it optimal to:

- Bid $P_{D_i} = \pi_D + (S - E)$ if the rival, firm D_j, bids any offer $P_{D_j} > \pi_D + (S - E)$ (surely rejected by the upstream firm) or does not submit any offer. P_{D_i} would be accepted, securing firm D_i a higher payoff than any lower offer, which firm U would accept, as well as any higher offer, which firm U would reject leaving each downstream firms with the vertical separation profit π_D.

- Slightly undercut any rival's offer $\pi_N < P_{D_j} \leq \pi_D + (S - E)$.[46] Bidding above the rival would leave firm D_i as the independent firm under vertical integration, with payoff π_N. Matching the rival's offer would give firm D_i equal probability of being independent or integrated, with expected profit $\frac{1}{2}(P_{D_j} + \pi_N)$. Undercutting the rival's offer by an arbitrarily small amount $\epsilon > 0$, would guarantee firm D_i to be integrated at the price and profit $P_{D_j} - \epsilon > \frac{1}{2}(P_{D_j} + \pi_N) > \pi_N$.

- Bid, indifferently, any offer $P_{D_i} \geq \pi_N$ if the rival bids $P_{D_j} \leq \pi_N$. Firm D_i's profit would equal π_N in any case, either because it will be the independent firm under vertical integration (if $P_{D_i} > P_{D_j}$) or because it will have equal probability of being independent or integrated at price π_N (if $P_{D_i} = P_{D_j} = \pi_N$).

It follows that, in equilibrium, at least one firm must offer π_N, while the other is indifferent between any offer greater than or equal to π_N. This usual "latitude" in the equilibrium set with symmetric undercutting strategies is fully irrelevant for the equilibrium outcome of our integration game: firm U will accept the takeover offer $P^* = \pi_N$ (gaining more than the net surplus form integration) and both downstream firms will symmetrically expect to earn π_N (either because randomly selected as the merging firm, or because surely left outside the merger as an independent firm).

Violation of condition (2) implies $\pi_D + (S - E) < \pi_D$. In this case, there are two possible equilibrium outcomes. The one derived above, leading to vertical integration at the takeover price π_N, and the one selected in the statement of the lemma, where each downstream firm submits an offer which firm U would surely reject (any offer $P > \pi_D + (S - E)$ will do), and the latter reject leaving both downstream firms with profit π_D. Clearly, no downstream firm has now an unilateral incentive to deviate from its equilibrium strategy by making an offer $P \leq \pi_D + (S - E) < \pi_D$ which firm U would surely accept. Vertical integration therefore does not occur.

[46] Recall that, by (A1.2), $\pi_N(\gamma) < \pi_D(\gamma)$ for any $\gamma \in (0, 1)$.

From the viewpoint of the downstream firms (the only active players at the bidding stage of the integration game), the first equilibrium outcome is strictly Pareto dominated by the second, adopted in the text. Pareto dominance is therefore a first selection criterion which would pin down the equilibrium adopted in the statement of the lemma. Furthermore, since the supporting equilibrium strategy of each player in the adopted equilibrium outcome (i.e., submit an offer which would surely be rejected) weakly dominates the player's supporting strategy in the discarded equilibrium outcome, only the former would survive trembling hand perfection or risk dominance refinements.

Proof of proposition 1. In appendix 2 (online), we calculate:

$$\begin{aligned} S^C(\gamma) &= \tfrac{2}{(2-\gamma^2)(\gamma+2)^2}\left(\tfrac{a}{2}\right)^2 \\ S^B(\gamma) &= \tfrac{\left(\gamma^3-\gamma^2-2\gamma+2\right)}{2(1+\gamma)(2-\gamma)^2}\left(\tfrac{a}{2}\right)^2. \end{aligned}$$

Parameter a is clearly irrelevant for the shape of the two functions on $[0,1]$. Plotting them gives the respective shapes stated in the proposition (the plots are also collected in appendix 2).

Proof of proposition 3. Part *i*). For $\widehat{\gamma} \in (0, \gamma_h]$, equations (12) and (7) imply:

$$\widehat{k}_h(\widehat{\gamma}) - \widehat{k}_p(\widehat{\gamma}) = 2\pi_N(\widehat{\gamma}) - 2\pi_D(\widehat{\gamma}),$$

which, by A1.2, is strictly negative for $\widehat{\gamma} \in (0,1)$.

Part *ii*). For $\widehat{\gamma} \in [\gamma_{m1}, \gamma_{m1}]$, equations (11) and (7) imply:

$$\widehat{k}_m(\widehat{\gamma}) - \widehat{k}_p(\widehat{\gamma}) = 2\pi_D(\widehat{\gamma}) - 2\left[\pi_D(\widehat{\gamma}) - \pi_D(1)\right] = 2\pi_D(1) > 0.$$

Part *iii*). In Appendix 2 (on-line), for the linear quadratic specification we calculate:

$$\begin{aligned} \widehat{k}_s(\widehat{\gamma}) &= 2\pi_N(\widehat{\gamma}) = 2\left(\tfrac{1-\gamma}{2-\gamma^2}\right)^2\left(\tfrac{a}{2}\right)^2 \\ \widehat{k}_p(\widehat{\gamma}) &= 2\left[\pi_D^C(\widehat{\gamma}) - \pi_D^C(1)\right] = \tfrac{2\left(5-4\gamma-\gamma^2\right)}{9(\gamma+2)^2}\left(\tfrac{a}{2}\right)^2. \end{aligned}$$

Plotting these two expressions (normalization of parameter a is irrelevant), we then show that $\widehat{k}_s(\widehat{\gamma}) \gtreqless \widehat{k}_p(\widehat{\gamma})$ implies $\widehat{\gamma} \lesseqgtr 0.89$.

Payoff matrix of the integration game in section 5.3.

		pair 2	
		v	s
pair 1	v	$\pi_I^{FI} - E$; $\pi_I^{FI} - E$	$\pi_I^{PI} - E$; $\pi_D^{PI} + \pi_U^{PI}$
	s	$\pi_D^{PI} + \pi_U^{PI}$; $\pi_I^{PI} - E$	$\pi_D^{SS} + \pi_U^{SS}$; $\pi_D^{SS} + \pi_U^{SS}$

[Appendix 2 (online) - separate annex]