Product market competition and boundaries of the firm

Jean-Etienne de Bettignies  Sauder School of Business, University of British Columbia

Abstract. This paper studies the effects of product market competition on firm boundaries. In a duopoly setting, each retailer is associated with a manufacturer who must decide how to allocate property rights over a retail asset. Delegating property rights over the retail asset to an independent retailer (‘disintegration’) transfers incentives from the manufacturer to the retailer and has the benefit of increasing product quality and profits, owing to the retailer’s superior efficiency. However, it also forces the manufacturer to forfit part of the profits. Competition increases the net benefit from delegation and leads to more efficient, vertically disintegrated structures. JEL classification: L13, L14, L22

Concurrence sur le marché des produits et théorie de la firme. Cet article étudie la concurrence sur le marché des produits et ses effets sur les limites de l’entreprise. Dans un modèle de duopole, chaque producteur, associé à un distributeur, choisit soit une structure verticale ‘intégrée’ dans laquelle le distributeur est son employé, soit une structure ‘désintégrée’ dans laquelle le distributeur est indépendant. Plus efficace en termes d’incitations au distributeur, la structure désintégrée génère des profits joints plus importants. Elle oblige cependant le producteur à partager les profits avec le distributeur. La concurrence augmente le bénéfice et réduit le coût de la désintégration, favorisant ainsi des structures verticales désintégrées et efficaces.

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1. Introduction

A common belief among economists is that product market competition leads to efficiency improvements in firms. Much of the recent work on the subject has focused on efficiency gains that result from the mitigating effects of competition on agency costs (see, e.g., Hart 1983; Scharfstein 1988; Hermelin 1992; Schmidt 1997; Raith 2003; Baggs and de Bettignies 2005). Another explanation for this can be traced back to what Stigler (1958) called the ‘survivor principle’: competition improves efficiency by weeding out the weaker firms, leaving only the more efficient firms in the industry. In this paper we offer a third explanation, based on the idea that the efficiency gains brought about by competition may come through changes in the boundaries of the firm.

Specifically, the objective of this paper is to provide a theoretical framework to analyse the effects of competition on manufacturers’ choice between operating through firm-owned outlets and hiring retail managers (integration) and distributing their products via independent retailers (disintegration). We use the ‘Property Rights Approach’ (Grossman and Hart 1986; Hart and Moore 1990, henceforth GHM) as our point of departure: we assume that contracts are incomplete and specify only who owns the retail asset, and that both the manufacturer and the retailer make ex ante investments in effort that increase product quality. However, we depart from GHM’s basic model in two critical ways. First, we make the additional assumptions that (i) retailers are more ‘efficient’ than manufacturers, since they have a higher marginal return to effort; and (ii) retailers are wealth constrained with zero initial wealth (in that regard, we follow Aghion and Tirole 1994). This framework allows us to explicitly identify a benefit and a cost of vertical disintegration. On the one hand, allocating property rights to the retailer has the advantage of transferring ex post bargaining power, and hence incentives, to the (more efficient) retailer, leading to a net increase in product quality. On the other hand, owing to the wealth constraint, disintegration forces the manufacturer to forfeit expected ex post rents, to the retailer.

More important, unlike GHM, we explicitly take product market rivalry into account in our analysis of the trade-off between integration and disintegration. We consider a duopoly setting in which two manufacturer/retailer pairs sell imperfectly substitutable products. Competition – measured by the degree of substitutability between the two goods – has two effects. It reduces price-cost margins through a ‘rent-reduction’ effect. It also makes demand more elastic and thus further increases demand for the firm with a quality advantage through a ‘business stealing’ effect.

We use our model to derive three main results. (1) Competition, through the interaction of business stealing and rent reduction, unambiguously increases the net benefit from disintegration. (2) At the industry level, the Nash equilibrium in vertical structure changes as the degree of competition intensifies, leading firms to switch (in steps) to less integrated structures. (3) By improving
quality, competition increases efficiency at both the firm and the industry levels.

In recent years, several authors have examined the impact of product market competition on firms’ vertical structure choices. Bonanno and Vickers (1988) argue that price-competing firms may try to commit to raise prices to soften competition and increase profits.\(^1\) Disintegration, by generating double marginalization, offers precisely this commitment, and the associated benefit may more than offset the cost in terms of lower output. Gal-Or (1999) posits that manufacturers can obtain demand information from retailers more easily (at a fixed monitoring cost) when the retailing function is part of the firm than under disintegration, in which case a revelation game must be used. Competition lowers the cost of eliciting truthful revelation and hence may lead to more disintegration. Chen (2001, 2005) develops models of competition in both upstream and downstream markets, where one of the upstream firms has a cost advantage. He shows that strategic purchasing by downstream rivals may lead to integration, or disintegration, depending on whether the efficient supplier’s cost advantage is exogenous, or the result of learning-by-doing. Finally, in Grossman and Helpman’s (2002) general equilibrium framework, the effects of competition on outsourcing depend on several factors, including governance costs in integrated structures, hold-up problems à la Williamson (1985) associated with outsourcing, and firms’ ability to find suitable suppliers.

Over the same period, the property rights approach established itself as a compelling and powerful way to formalize the theory of the firm. Yet GHM’s basic model says little about the impact of competition on firm boundaries.\(^2\) Indeed, the property rights literature and the competition-and-integration literature evolved in parallel, without much intersection. By adapting the property rights framework to explicitly take product market competition into account, this paper provides a valuable link between the two literatures.

The paper is organized as follows. Sections 2 and 3 describe the basic model, and the trade-off between integration and disintegration, respectively. Section 4 analyses the effects of competition, and section 5 focuses on the retailer/manufacturer relative efficiencies. Section 6 concludes.

\(^1\) Their argument rests on the strategic complementarity of prices. See also Gal-Or (1991), Shaffer (1991), and Rey and Stiglitz (1995).

\(^2\) GHM’s key result is that property rights should be assigned to the most efficient agent in the vertical relationship. An implication of this insight is that competition will increase the benefit from disintegration relative to integration if and only if it increases the retailer's efficiency relative to the manufacturer's. But does competition affect relative efficiencies? And if so, how? Answering these questions requires the explicit modelling of the competitive interaction between firms, a feature that is central in this paper but absent from GHM’s basic framework. We show that the impact of competition on relative efficiencies, and hence on the benefit from disintegration, occurs through a combination of business stealing and rent-reduction effects and depends on the rival firm’s vertical structure choice. Moreover, when retailers are wealth constrained (a further departure from GHM), a cost of disintegration arises, which unambiguously falls with competition. As stated above, in our model competition unambiguously increases the net benefit from disintegration.
2. Basic model

Consider two identical pairs of risk-neutral players, each pair composed of a manufacturer and a retailer. Together, manufacturer \( i \) and retailer \( i, i = 1, 2 \), can produce a good \( i \), of quality \( q_i \), which the retailer can sell at price \( p_i \). Marginal costs of production are normalized to zero.

Each manufacturer-retailer pair is located at one end of a Hotelling (1929) line of unit length: retailer 1 is at \( x = 0 \), while retailer 2 is at \( x = 1 \). There are \( n \) consumers independently uniformly distributed with density 1 along the Hotelling line. A consumer located at \( x \) incurs a transport cost \( t_x \) for travelling to retailer 1, and a cost \( t(1 - x) \) to visit store 2. That consumer enjoys conditional indirect utility \( V_1 = y + q_1 - p_1 - t_x \) from product 1 and \( V_2 = y + q_2 - p_2 - t(1 - x) \) from product 2 (where \( y \) represents income) and simply chooses the product that gives the highest utility.

The timing of the (perfect information) game is as follows:

At date 0, manufacturer \( i, i = 1, 2 \), has full bargaining power and offers a take-it-or-leave-it contract to its retailer. As discussed below, we assume that contracts are incomplete and specify only the allocation of property rights over the retailing asset. With a vertical integration contract, the manufacturer retains ownership of the retailing asset, and operates via a firm-owned outlet where the retailer is an employee. Under vertical disintegration, the manufacturer allocates property rights to the retailer and deals with him\(^3\) at arm’s length.

At date 1, the two manufacturer-retailer pairs compete in product quality. Both manufacturers and retailers can make ex ante investments to affect product quality. Specifically, manufacturer \( i, i = 1, 2 \), can make either a low investment \( f_{i\ell} \) at cost \( K_{im}(f_{i\ell}) = k_{i\ell} \) or a high investment \( f_{i\hbar} \) at a personal cost \( K_{in}(f_{i\hbar}) = k_{i\hbar} \). Retailer \( i \) invests in effort and can choose between low-effort \( e_{i\ell} \) at cost \( K_{ir}(e_{i\ell}) = k_{i\ell} \) and high-effort \( e_{i\hbar} \) at cost \( K_{ir}(e_{i\hbar}) = k_{i\hbar} \). The retailer’s effort is not verifiable.\(^4\) Naturally, we assume that quality is strictly increasing in ex ante investments: \( q_i(f_{i\hbar}, e_{i\ell}) > q_i(f_{i\ell}, e_{i\ell}) \), and \( q_i(f_{i\hbar}, e_{i\hbar}) > q_i(f_{i\ell}, e_{i\ell}) \). We also make the simplifying assumption that the effect of the manufacturer’s investment on quality is independent of the retailer’s level of effort and vice-versa: \( q_i(f_{i\hbar}, e_{i\ell}) - q_i(f_{i\ell}, e_{i\ell}) = q_i(f_{i\hbar}, e_{i\hbar}) - q_i(f_{i\ell}, e_{i\ell}) \), and \( q_i(f_{i\hbar}, e_{i\hbar}) - q_i(f_{i\hbar}, e_{i\ell}) = q_i(f_{i\ell}, e_{i\hbar}) - q_i(f_{i\ell}, e_{i\ell}) \).

At date 2, the two manufacturer-retailer pairs compete in price, taking qualities as given. Manufacturer \( i, i = 1, 2 \), determines the optimal price \( p_i(q_i, q_j, t) \).\(^5\)

At date 3, three events occur simultaneously. (a) The nature of the product becomes describable in a contract, and thus the following (trade) contracts can be enforced. (b) Each consumer purchases one unit of the product from one of

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\(^3\) For clarity, we assume throughout the text that manufacturers are female and retailers are male.

\(^4\) As noted in Aghion and Tirole (1994), the manufacturer’s investment in the project could be verifiable or non-verifiable. When manufacturers have ex ante bargaining power, the two cases are identical.

\(^5\) It would make no difference if the retailer were to set prices in our model. For convenience, we give that decision right to the manufacturer.
the two retailers, say, retailer \(i\), at price \(p_i\). We express the resulting realized gross revenue/profits for retailer \(i\) as follows: \(\Pi_i = p_iD_i\), where \(D_i\) represents realized demand for retailer \(i\), for \(i = 1, 2\). (c) Manufacturer \(i\) supplies the products to retailer \(i\); in exchange she receives transfer payment \(z_i\) from the retailer. The equilibrium payment \(z_i\) is the result of Nash bargaining between the manufacturer and the retailer, who keeps the remaining \(\Pi_i - z_i\).

We restrict our attention to values of the transport cost \(t > t\), where \(t = \max(|q_i - q_j|)\). As will become clear, this is sufficient to ensure strictly positive equilibrium prices (see (2) below). It also ensures strictly dominating effort choices for all agents in the date 1 subgames, which greatly simplifies the model and improves presentation. In addition, we make three important assumptions.

First, we assume that contracts are incomplete and can specify only the allocation of property rights at date 0. Transaction costs and the consequent incompleteness of contracts are central themes in the study of the boundaries of the firm. This assumption fits squarely within the recent literature on incomplete contracting and is standard in that line of research (see, e.g., Grossman and Hart 1986; Hart 1995, Hart and Moore 1988, 1990, 1998; Bolton and Scharfstein 1990, 1996; Aghion and Tirole 1994; Gertner, Scharfstein and Stein 1994). We introduce contractual incompleteness by assuming, first, that the exact nature of the product – that is, an exhaustive definition that includes all possible characteristics of the product along all possible dimensions – cannot be described unambiguously in a contract at date 0; and, second, that cash flows, though they are observable to manufacturers and retailers, cannot be verified by third parties such as courts. These constraints prevent the manufacturer and retailer from writing any kind of effective long-term contract. Thus, initial contracts specify only the allocation of property rights on the retailing asset, and the parties bargain over the surplus from scratch at the end of the game.

Second, we assume that retailers are wealth constrained and have zero initial wealth. This prevents the manufacturer from extracting any ex ante rents (because that would imply negative income for the retailer). Therefore, any ex post bargaining power and associated ex post rents relinquished by the manufacturer are forfeited for good. This assumption creates a cost of delegating ownership: a loss of ex post rents that cannot be recouped through ex ante transfers.

Finally, we assume that retailers are more efficient than manufacturers in two ways. First, we assume that the marginal impact of an increase in effort on quality is higher for the retailer than for the manufacturer: \(q_i(f_{il}, e_{il}) \geq q_i(f_{ih}, e_{ih})\). This may occur, for example, if the consumer’s perception of quality depends more on the retailer’s input than on the manufacturer’s. Note that this is possible even if the

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6 This could arise, for example, if retailers can spend cash flows on ‘perks’ that ‘may be difficult to distinguish from appropriate business decisions’ (Bolton and Scharfstein 1996).

7 For the same reason, it also rules out the possibility of the retailer’s owning the manufacturer’s asset and allows us to focus on the allocation of property rights over the retailing asset. The manufacturer has no incentive to allocate the control rights over his own asset to the retailer, since the retailer, being wealth constrained, would not be able to compensate her (at date 0) for it.
two players exert identical nominal effort levels and are hence not intrinsically different. Second, we assume that the personal cost of exerting high effort is lower for the retailer than for the manufacturer: \( k_{ir} \leq k_{im} \). This may be the case when the retailer has superior information about the market, for example, and can use his information to target his effort to situations where it is relevant. The manufacturer who cannot target this information essentially has a higher cost of effective effort. These two conditions are sufficient to ensure that the expected total surplus (expected profits minus personal costs) is larger when high effort is exerted by the retailer than when it is exerted by the manufacturer:

\[
\pi_i(q_i(f_{ih}, e_{ih}), q_j, t) - k_{ir} \geq \pi_i(q_i(f_{il}, e_{il}), q_j, t) - k_{im},
\]

where \( \pi_i = E(\Pi_i) \) represents expected profits for pair \( i \).

In order to offer a simple and clear presentation, the contractual environment is highly stylized. The key results of the paper, however, would carry through with weaker assumptions. For example, we posit that contracts at date 0 specify only the allocation of property rights. In fact, we really only need ‘enough’ contractual incompleteness to prevent economic agents from circumventing moral hazard problems through contractual means. The conditions necessary for this to occur – namely, that details about future production and trade are difficult to express clearly in a date 0 contract – are not improbable in our opinion. Indeed, uncertainty about the technology required to produce the good or about consumers’ notoriously fickle tastes may suffice to generate such conditions.

Even with verifiable profits, it may not be possible to address moral hazard issues through contractual means (e.g., through profit sharing) when, as implied by the above, the conditions of trade at the end of the game cannot be precisely

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8 For example, one may care more about the benefits provided by the hairdresser (hair-cutting skills, good conversation) than about the brand name of the hairdressing chain. An easy way to model this, for example, would be to assume that \( k_{ir} = k_{im} \), \( e_{ih} = f_{ih}, e_{il} = f_{il} \), and \( q_i(f_i, e_i) = f_i + ze_i - c \), with \( z > 1 \).

9 We thank an anonymous referee for this suggestion. Assume that \( q_i(f_i, e_i) = q_i(f_{ih}, e_{ih}) \), but that whether there exists a market for the good produced is uncertain: with probability \( \gamma \), market demand is as we have described it so far, but with probability \( (1 - \gamma) \), it equals zero. Then the retailer, who knows when a market exists, exerts effort only a fraction \( \gamma \) of the time, whereas the manufacturer must exert effort at all times to have the same expected benefit. This is equivalent to having \( k_{ir} = \gamma k_{im} \). For example, the manager of a grocery store in a particular neighbourhood may have knowledge of local tastes and successful products (e.g., organic food) and may target his effort to provide these products. In contrast, the grocery store chain management would waste much investment on products for which there is no market in that particular location.

10 Our second and third assumptions are also stronger than required for our results to hold. For instance, retailers are not strictly required to have exactly zero initial wealth. This assumption is simply meant to capture the idea that, even if retailers have some wealth, it will likely be smaller than the present value of future rents expected from the venture, and that therefore the manufacturer may be not be able to recoup ex ante all of the ex post rents she would want to forfeit to the retailer for incentive purposes. Kaufmann and Lafontaine (1994) found evidence of both ex ante and ex post rents left by McDonald’s to its franchisees. Like us, they argued that franchisee wealth constraints prevented McDonald’s from extracting all ex ante rents. Similarly, the strength of our third assumption simplifies presentation, but as discussed in section 5, the same overall result would obtain with weaker conditions, as long as they satisfy condition (1).
defined at date 0, because agents could threaten not to trade (paraphrasing Hart and Moore 1990). In such a case, property rights would still play an important role. Allowing for a richer environment and/or weaker conditions may affect the relative size of benefits and costs of disintegration, but the basic intuition of the model would likely remain unchanged. Some examples are discussed in section 5.

3. Integration versus disintegration

In order to analyse manufacturers’ vertical structure choices, we proceed by backward induction.

3.1. Ex post bargaining

At date 3, under integration, if bargaining breaks down, the manufacturer can just fire her employee-retailer – who then gets nothing – and keep all profits, because she owns the underlying retailing asset. Thus alternative payoffs are $\Pi_i$ and 0 for the manufacturer and the retailer, respectively. Nash bargaining yields an equilibrium transfer $z_{iman} = \arg\max((\Pi_i - z - 0)(z - \Pi_i)) = \Pi_i$ to the manufacturer: she obtains all ex post rents and the retailer gets nothing.

Under disintegration, both parties can prevent any sale from happening if bargaining breaks down. The retailer owns the retail asset and can refuse to distribute the product; similarly, the manufacturer can refuse to provide the product for distribution. We assume that if trade breaks down, no sale occurs and profits are null for both of them. Nash bargaining thus yields equilibrium transfer $z_{iret} = \arg\max((\Pi_i - z - 0)(z - 0)) = \Pi_i/2$: the manufacturer and the retailer share the profits equally.

3.2. Optimal pricing

At date 2, manufacturers compete in price, taking qualities determined at date 1 as given. Under both ownership structures, the manufacturer’s expected payoff is proportional to expected profits (either $\pi_i$ or $\pi_i/2$, minus perhaps a constant $k_{im}$ if high effort has been exerted). Therefore, regardless of ownership structure, maximization of her expected payoff is equivalent to profit maximization: $p_i \in \arg\max p_i d_i(q_i, p_i, q_j, p_j, t)$, where expected demand $d_i = E(D_i)$ is $d_i(q_i, p_i, q_j, p_j, t) = n((1/2) + ((p_j - p_i) + (q_i - q_j))/2t)$.\(^{11}\) Taking the first-order conditions\(^{12}\) for $p_i$, solving and substituting back into the profit function, we obtain

$$\pi_i(q_i, q_j, t) = n \left[ \frac{(q_i - q_j)}{3} + t \right] \left[ \frac{1}{2} + \frac{(q_i - q_j)}{6t} \right], \quad (2)$$

where the price is $p_i = (q_i - q_j)/3 + t$, and demand is $d_i = n[(1/2) + (q_i - q_j)/6t]$.

\(^{11}\) A consumer located at $x$ is indifferent between store 1 and 2 if and only if $V_1 = V_2$ or $q_1 - p_1 - tx = q_2 - p_2 - t(1 - x)$. Solving for $x$, we get the expected ‘total’ demands for firms 1 and 2, respectively: $d_1(q_1, p_1, q_2, p_2, t) = nx = n((1/2) + ((p_2 - p_1) + (q_1 - q_2))/2t)$, and $d_2(q_2, p_2, q_1, p_1, t) = n(1 - x)$.

\(^{12}\) The second order-condition gives $-1/t$, which is strictly negative.
3.3. Ex ante investments and date 1 subgames

From a date 1 perspective, the retailer has more incentives to exert high effort under disintegration, in which case he expects to obtain half of the profits, than under integration, in which case he gets nothing. Conversely, the manufacturer has more incentives under integration than under disintegration. Therefore, a switch from integration to disintegration improves the retailer’s incentives at the expense of the manufacturer’s. More formally:

**Lemma 1.** For values of $t > t_0$, with $t = \max(|q_i - q_j|)$, given any technology $q(f, e)$ that meets the conditions described in section 2, there exists a set of values for variables $f_h, f_l, k_m, e_h, e_l, k_r$, such that (1) under integration, high effort and low effort are strictly dominating strategies for the manufacturer and the retailer, respectively; and (2) under disintegration, low effort and high effort are strictly dominating strategies for the manufacturer and the retailer, respectively.

**Proof.** See appendix.

In this paper we focus on values of $t > t_0$ and on sets of variables $f_h, f_l, k_m, e_h, e_l, k_r$, such that lemma 1 holds. We define $q_{1D} = q_i(f_l, e_h)$ and $q_{1I} = q_i(f_h, e_l)$ as the qualities of product $i$ when manufacturer $i$ has chosen disintegration ($D$) and integration ($I$), respectively. There are four possible subgames at date 1, corresponding to the manufacturers’ disintegration/integration decisions at date 0. Under lemma 1, there exists a unique Nash equilibrium in each of the subgames, in which each player chooses his/her strictly dominating strategy. The resulting equilibrium qualities can be summarized in the following table:

<table>
<thead>
<tr>
<th>Manuf. 2 \ Manuf. 1</th>
<th>Disintegrates</th>
<th>Integrates</th>
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<tbody>
<tr>
<td>Disintegrates</td>
<td><strong>Subgame 1</strong></td>
<td><strong>Subgame 3</strong></td>
</tr>
<tr>
<td></td>
<td>$q_1 = q_{1D}$ and $q_2 = q_{2D}$</td>
<td>$q_1 = q_{1I}$ and $q_2 = q_{2D}$</td>
</tr>
<tr>
<td>Integrates</td>
<td><strong>Subgame 2</strong></td>
<td><strong>Subgame 4</strong></td>
</tr>
<tr>
<td></td>
<td>$q_1 = q_{1D}$ and $q_2 = q_{2I}$</td>
<td>$q_1 = q_{1I}$ and $q_2 = q_{2I}$</td>
</tr>
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</table>

13 This is consistent with empirical evidence. Lafontaine (1992) finds a negative relationship between the amount of training offered by the franchisor and the propensity to franchise. Arruñada and Vazquez (1999) document lower labour costs and greater efficiency (presumably reflecting higher retailer effort) in independent rather than integrated car dealerships.

14 It can easily be shown that under lemma 1, both the manufacturer and retailer would choose high effort in the first-best (i.e., total surplus maximizing) case. Quality would thus be $q_i = q_i^*(f_h, e_h)$, which is superior to the second-best qualities $q_{1D}$ and $q_{1I}$ obtained in the model. This well-known result from GHM comes from the fact that in the second best both manufacturer and retailer cannot, at the same time, expect to receive all of the surplus.
3.4. Benefit and cost of vertical disintegration

Let $\pi_{iXY}$ denote expected profits for pair $i$, given that it has vertical structure $X$ while his rival has structure $Y$, where $X, Y = D, I$. At date 0, given manufacturer $j$’s choice $Y = D, I$, manufacturer $i$ prefers disintegration over integration if and only if the former vertical structure gives her a higher expected payoff than the latter: \[ \frac{1}{2} \pi_{iDY}(q_{iD}, q_{jY}, t) \geq \pi_{iIY}(q_{iI}, q_{jY}, t) - k_{im}. \]

Noting – as should be clear from equation (2) – that profit functions in our model depend on the difference in quality offered, that is, on the quality (dis)advantages, and rearranging, we can rewrite this condition as follows:

\[
\frac{1}{2} \left[ \pi_{iDY}(q_{iD} - q_{jY}, t) - \pi_{iIY}(q_{iI} - q_{jY}, t) \right] \\
- \left[ \frac{1}{2} \pi_{iIY}(q_{iI} - q_{jY}, t) - k_{im} \right] \geq 0. \tag{3}
\]

Condition (3) highlights both the benefit from and the cost of choosing a vertically separated structure over integration. The first term is the benefit from disintegration. It measures the marginal return to the retailer’s effort relative to the marginal return to the manufacturer’s effort. When disintegration is chosen over integration, the retailer’s ex post bargaining power, and hence his incentives, are increased, inducing him to exert high effort. This comes at the expense of the manufacturer’s ex post bargaining power, which decreases, in turn reducing her incentives and inducing her to choose low effort. Since the marginal efficiency (in terms of quality) of the retailer’s effort is higher than that of the manufacturer, choosing disintegration over integration leads to an increase in product quality ($q_{iD} > q_{iI}$). This increase in quality in turn increases expected profits. Thus the benefit from disintegration is that it allows the manufacturer to take advantage of the retailer’s superior marginal efficiency.

The second factor in condition (3) is the opportunity cost of disintegration. When the manufacturer relinquishes property rights to the retailer, she gives up ex post bargaining power to the retailer, who is able to extract half of the expected ex post surplus, but she doesn’t incur the personal cost of effort $k_{im}$. Her net opportunity cost of disintegration is thus $1/2 \pi_{iI}(q_{iI} - q_{jY}, t) - k_{im}$.

4. The effects of product market competition

Exogenous transport cost $t$ is the crucial parameter in our model, as it can be interpreted as the degree of horizontal differentiation and thus of ‘toughness of competition’ (Sutton, 1992, 9.), or rather lack thereof. When $t$ falls, it becomes cheaper for the consumer to travel, and he cares relatively less about distance to a retailer and more about the dimensions in which the rivals compete, namely, quality and price: products become more substitutable and the degree of competition rises.
An increase in competition has two direct effects in our model. First, it lowers the competing firms’ price-cost margins, a measure of their market power. As $t$ falls and consumers can travel more easily, they become more sensitive to prices and qualities, thus forcing firms to compete more fiercely and to lower their margins. We call this the rent-reduction effect.

The second factor tends to affect demand when competing firms offer different qualities. Consider a scenario where a particular firm, say, firm 1, has a quality advantage over its competitor, firm 2. As long as transport cost $t$ is positive, firm 2 still makes a positive profit, even though it is lower than that of firm 1. As competition intensifies, consumers become more sensitive to the fact that firm 1 has superior quality, and the difference in demands between the two firms rises. Firm 1 is able to steal business from the lower-quality firm. This is the business-stealing effect.

In what follows we analyse how these two factors combine to affect both the benefit from and the cost of disintegration.

### 4.1. Competition and the benefit from vertical disintegration

#### 4.1.1. Rival $j$ plays ‘integration’

If rival $j$ plays integration, manufacturer $i$’s benefit from choosing disintegration over integration is $B_{i/Y=I} = \frac{1}{2} \left[ \pi_i^{DI}(q_{iD} - q_{jI}, t) - \pi_i^{III}(q_{iI} - q_{jI}, t) \right]$, where $q_{iD} - q_{jI} = 0$. Recalling that $\pi_i^{XY} = p_i^{XY} d_i^{XY}$, where $X, Y = D, I$, and differentiating $\pi_i^{DI} - \pi_i^{III}$ with respect to $t$, we can isolate the business-stealing and rent-reduction effects:

$$\frac{\partial B_{i/Y=I}}{\partial t} = \frac{\partial \left[ \pi_i^{DI} - \pi_i^{III} \right]}{\partial t} = p_i^{DI} \frac{\partial d_i^{DI}}{\partial t} + \frac{\partial p_i}{\partial t} (d_i^{DI} - d_i^{III}),$$

where $\frac{\partial p_i}{\partial t} = \frac{\partial p_i^{DI}}{\partial t} = \frac{\partial p_i^{III}}{\partial t}$.

When rival $j$ chooses integration, $q_j = q_{jI}$, and hence firm $i$ is weakly more efficient than rival $j$, regardless of the organizational structure $i$ chooses, it will offer weakly superior product quality than rival $j$ ($q_{iD}, q_i \geq q_{jI}$). Choosing disintegration in that case is a way for manufacturer $i$ to gain a strictly quality advantage ($q_{iD} > q_{jI}$) and to increase demand to a higher level. Competition, by making consumers more sensitive to quality and price advantages, increases that demand advantage. Thus, the business-stealing effect of competition has a positive impact on the difference in profits $\pi_i^{DI} - \pi_i^{III} : p_i^{DI} (\partial d_i^{DI} / \partial t) < 0$. In contrast, the rent-reduction effect has a negative impact on $\pi_i^{DI} - \pi_i^{III}$: an equal reduction in price induces $\pi_i^{DI}$ to fall more than $\pi_i^{III}$ because it is multiplied by a higher demand: $(\partial p_i / \partial t) (d_i^{DI} - d_i^{III}) > 0$. The sign of (4) may thus appear ambiguous.

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15 To see this, substitute 1 and 2 for $i$ and $j$ in (2), and look at the effect of a fall in $t$ on expected demand for firms 1 and 2.

16 The business-stealing and rent-reduction effects are also discussed in different contexts in Anderson, de Palma, and Thisse (1992, 230), Raith (2003), and Baggs and de Bettignies (2005).
However, as shown in the appendix, when disintegration enables a firm to gain a quality advantage, the positive business stealing effect of competition is large enough to offset the negative rent-reduction effect (more detail on this just below). In other words, here competition increases the retailer’s marginal return to investment relative to the manufacturer’s. More formally:

**Lemma 2.** When rival \( j \) is integrated, choosing disintegration enables manufacturer \( i \) to gain a strict quality advantage over her rival by relying more on her retailer’s superior efficiency. Product market competition raises the value of that quality advantage and (strictly) increases manufacturer \( i \)'s benefit from choosing disintegration over integration: \( \partial B_i / \partial Y = 1 / \partial t < 0 \).

**Proof.** See appendix. ■

4.1.2. Rival \( j \) plays ‘disintegration’

If rival \( j \) plays disintegration, manufacturer \( i \)'s benefit from choosing disintegration over integration is

\[
B_i(Y = D) = \left[ \pi_{iDD}(q_i, t) - \pi_{iID}(q_{ij}, t) \right]/2,
\]

where \( q_i - q_{ij} = 0 \). Again we can analyse the effects of competition by isolating the business-stealing and the rent-reduction effects:

\[
\frac{\partial B_i(Y = D)}{\partial t} = \frac{\partial \left[ \pi_{iDD} - \pi_{iID} \right]}{\partial t} = -p_{iID} \frac{\partial d_{iID}}{\partial t} + \frac{\partial p_i}{\partial t} (d_{iDD} - d_{iID}).
\] (5)

When rival \( j \) chooses disintegration, firm \( i \) is weakly less efficient than rival \( j \), since \( q_{iD}, q_{ij} \leq q_{jD} \). In that case, for manufacturer \( i \) choosing integration means facing a strict quality disadvantage and lower demand. Increased competition accentuates the demand disadvantage and allows rival \( j \) to steal business from \( i \). Disintegration, which allows \( i \) to avoid this business-stealing cost, becomes relatively more attractive: \( -p_{iID}(\partial d_{iID}/\partial t) < 0 \). The rent-reduction is the same as before: an equal reduction in price induces \( \pi_{iDD} \) to fall more than \( \pi_{iID} \) because it is multiplied by a higher demand: \( (\partial p_i/\partial t) (d_{iDD} - d_{iID}) > 0 \).

Unlike the previous scenario (in which rival \( j \) plays integration), here competition decreases the retailer’s marginal return to investment relative to the manufacturer’s. Competition reduces the benefit from disintegration: the sign of (5) is positive. This is an important result and the intuition is simple: whereas in the previous scenario the business-stealing effect was large enough to offset the rent-reduction effect, this is not the case when rival \( j \) plays disintegration. The difference between (4) and (5) comes from price-cost margin differences. A firm with a quality advantage can charge a higher price and hence receives a larger price-cost margin, relative to a firm with a quality disadvantage. This yields

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17 In what follows we may refer to the situation in which rival \( j \) chooses disintegration as one where firm \( i \) is relatively inefficient or ‘weak’; and, conversely, to the situation in which rival \( j \) chooses integration as one where firm \( i \) is relatively efficient or ‘strong.’
\( p_{iDi} > p_{iID} \) and explains why the business stealing effect is larger in the former case than in the latter one. (We show in the appendix that the rent-reduction effect is the same regardless of the rival manufacturer’s choice and that \( \partial d_{iDi}/\partial t = -\partial d_{iID}/\partial t \).) We summarize these results in the following lemma:

**Lemma 3.** When rival \( j \) is disintegrated, choosing disintegration enables manufacturer \( i \) to eliminate the strict quality disadvantage she would face under integration. Product market competition reduces the value of eliminating that quality disadvantage and (strictly) decreases manufacturer \( i \)'s benefit from disintegration: \( \partial B_{i/Y=D}/\partial t > 0 \).

**Proof.** See appendix.

### 4.2. Competition and the cost of vertical disintegration

The effect of competition on the cost of disintegration is evident. Regardless of rival \( j \)'s choice of vertical structure \( Y = D, I \), manufacturer \( i \)'s expected profits if she chooses integration, \( \pi_{iY}(q_{iI} - q_{jY}, t) \), fall with competition, thus lowering the opportunity cost of disintegration.

**Lemma 4.** Regardless of manufacturer \( j \)'s action, competition (strictly) decreases manufacturer \( i \)'s opportunity cost of disintegration: \( \partial (\pi_{iY}/2)/\partial t > 0 \), with \( Y = D, I \). Moreover, this effect is stronger when rival \( j \) plays integration than when she plays disintegration.

**Proof.** See appendix.

The intuition behind the second part of this lemma is exactly the same as that behind lemma 3. Indeed, substituting equilibrium qualities into (2), we can deduce that \( \pi_{iII} = \pi_{iIDD} \). As a result, the difference in the effects of competition on the cost of disintegration, \( \partial (\pi_{iII}/2 - \pi_{iID}/2)/\partial t \), can be expressed as \( \partial (\pi_{iDD}/2 - \pi_{iID}/2)/\partial t \), which is the same as in (5). Rent reduction affects the opportunity cost of disintegration more when the rival plays integration, because the fall in price is multiplied by a larger market share for \( i \). On the other hand, the business-stealing effect reduces the cost of delegation when the rival plays disintegration, but is not strong enough to offset the rent reduction.

### 4.3. Overall effect of competition and equilibrium industry structure

**When rival \( j \) plays integration**, competition in the product market raises manufacturer \( i \)'s benefit from disintegration while reducing its cost, thereby strictly increasing its net benefit. This net benefit is negative at high levels of product differentiation (low levels of competition) but becomes positive as the degree of differentiation falls below a threshold \( t_f \).
When rival j plays disintegration, competition lowers i’s cost of delegation but also has a negative effect on the benefit. However, it can easily be shown that for all $t > t$, the impact of competition on the cost of delegation dominates its impact on the benefit from disintegration, and that therefore the net benefit from delegation strictly increases with competition. We show that there exists a threshold level of differentiation $t_D$ such that manufacturer $i$ delegates if and only if $t$ is less than $t_D$.

Moreover, as competition intensifies and $t$ falls, manufacturer $i$ switches from integration to disintegration ‘later’ if rival manufacturer $j$ is integrated than if she is not: $t_D > t_i$.18 The explanation is simple: although, as shown in lemmas 2–4, manufacturer $i$’s net benefit from disintegration increases faster as a function of competition (i.e., the slope is steeper) when rival $j$ is integrated, in fact the net benefit itself (i.e., its level) in that case is lower for all $t > t$.19 Since net benefit functions strictly increase as $t$ decreases, the net benefit from disintegration must cross the abscissa axis at a smaller value of $t$ when rival $j$ is integrated than when it is not.

We summarize these results in the following proposition:

PROPOSITION 1. For a given firm structure $Y = I, D$ chosen by rival $j$: (1) competition strictly increases the marginal return of the retailer’s investment relative to the manufacturer’s, net of delegation cost, thus making disintegration more ‘appealing’ for manufacturer $i$. (2) There exists a threshold degree of differentiation $t_Y$ such that it is optimal for manufacturer $i$ to choose disintegration if and only if $t \leq t_Y$, that is, if and only if competition is sufficiently intense. (3) $t_D > t_I$.

Proof. See appendix.

In the subgame perfect Nash equilibrium of the game, which follows directly from the foregoing analysis, vertical structure choices in the industry depend on the level of competition in the product market. The general result, which is stated more formally in the following proposition, is that competition leads to less integrated firm structures.

PROPOSITION 2. As competition intensifies, the equilibrium in the industry first switches from one where both manufacturers choose integration to one of two potential equilibria where either both manufacturers integrate or both disintegrate. As competition intensifies even more, a second switch occurs, leading to a new equilibrium where both manufacturers choose disintegration.

18 I thank an anonymous referee for pointing out this possibility.
19 Even though $i$’s benefit from disintegration is higher when rival $j$ is integrated, her opportunity cost of disintegration is also higher in that case, because she must give up a fraction of a larger expected profit. The difference in cost is actually larger than the difference in benefit, and hence the net benefit from disintegration is lower when rival $j$ is integrated.
**Proof.** Follows directly from proposition 1.

Consider first the case where \( t \in [t_I, t_D) \). Interestingly, at these moderate levels of differentiation, it is optimal for manufacturer \( i \) to disintegrate if and only if rival \( j \) disintegrates and vice-versa. The net benefit from disintegration is negative when disintegration yields a strict quality advantage over an integrated rival and leads to market leadership, but it is positive when it allows the manufacturer to ‘catch up’ with its disintegrated rival. In other words, a ‘herding’ or ‘bandwagon’ effect occurs, and as a result, either both firms integrate or both firms disintegrate.\(^{20}\)

Our analysis has shown, however, that competition unambiguously increases the net benefit from disintegration, and this is reflected in the industry outcome: when \( t \leq t_I \) and competition is intense, disintegration is optimal regardless of the rival’s organizational structure, and in equilibrium both firms disintegrate. Conversely, when \( t > t_D \) and the degree of competition is low, integration is a strictly dominating strategy for manufacturers, and in equilibrium both firms integrate.

Note, also, an interesting implication of propositions 1 and 2: disintegration in our model is associated with a quality increase, which itself reflects an increase in efficiency. Product market competition thus has a positive impact on efficiency by increasing quality closer to the first-best level.

**PROPOSITION 3.** Under assumption 3, product market competition has a positive effect on efficiency at the firm level, as it leads to an increase in quality towards the first best. Moreover, competition works on all firms and leads to a gradual increase in overall efficiency at the industry level.

**Proof.** Follows directly from propositions 1 and 2.

5. Retailer efficiency versus manufacturer efficiency

In the model so far we have postulated that the retailer is more efficient than the manufacturer. In this section we take a closer look at the relative efficiency. We highlight the importance of the manufacturer’s investment as well as that of the retailer. Both investments are important components of vertical structure choices and key elements in the theory of the firm literature.

**Case where the manufacturer is more efficient than the retailer (cond. (1) fails)**

In this case, there is no benefit; there are only costs of disintegration. The optimal ownership structure and impact of competition are thus quite clear:

\(^{20}\) A bandwagon effect is also present in Gal-Or (1999), but only when demands are highly correlated. She does not analyse the case of negatively correlated demands, which is closer to the assumption implicitly made here through our use of the Hotelling line. Bandwagon effects are also present in the literature on vertical integration and foreclosure. See de Fontenay and Gans (2005) for a discussion.
LEMMA 5. *When the manufacturer is more efficient than the retailer, integration always dominates disintegration, and competition has no impact on vertical structure.*

**Proof.** Follows directly from above. ■

Lemma 5 stands in contrast to our base-case results, which state that competition has a positive impact on disintegration and efficiency when the retailer is more efficient than the manufacturer. Taking propositions 1, 2, and 3 and lemma 5 together, we conjecture that the positive effects of competition on disintegration and efficiency may be a weakly increasing function of retailer efficiency relative to manufacturer efficiency.

*Case where the retailer is more efficient than the manufacturer (cond. (1) holds), but with $q_i(f_{ih}, e_{ih}) < q_i(f_{ih}, e_{il})$, and $k_{ir} \leq k_{im}$*

In this case, the retailer’s marginal product (in terms of quality, and profits) from exerting high effort is lower than the manufacturer’s. On the other hand, the marginal cost of high effort is sufficiently low for the retailer relative to the manufacturer, and the marginal net benefit is still in favour of the retailer. The benefit and cost of disintegration can still be depicted as in (3), but the main difference with the basic model is that the benefit and cost are inverted. Here disintegration leads to a *decrease* in quality, and thus the first term in (3), which is now negative, represents the cost of disintegration. The second term in (3) represents the potential benefit\(^\text{21}\) from disintegration: it may be more beneficial to the manufacturer to give up half of the profits than to have to exert high effort herself, at cost $k_{im}$.

The effects of competition on the benefit and cost of disintegration are also inverted: competition unambiguously increases the benefit from disintegration, but its effect on the cost of disintegration depends on the rival’s strategy. However, overall the sign of the effect remains the same: competition leads to disintegration, and propositions 1 and 2 still hold.\(^\text{22}\) The effect of competition on efficiency, though still positive, works in a slightly different way:

**LEMMA 6.** *When the retailer’s efficiency advantage comes from low marginal cost of effort rather than high marginal product, product market competition may decrease product quality. Despite that, competition has a positive effect on efficiency, because it leads to a more than proportional decrease in investment costs and increases the total ex post surplus.*

**Proof.** Follows directly from condition (1). ■

This is an interesting lemma because it highlights the fact that the positive effects of competition on efficiency, though present, may fail to be noticed if

\(^{21}\) Only if $1/2\pi \left(q_i(f_{il}, e_{il}) - q_i(f_{ih}, e_{ih})\right) > k_{im}$.

\(^{22}\) The proofs are exactly the same as those in the basic model, but with $\Delta q = q_d - q_l < 0$. 
investment costs $k_{ir}$ and $k_{im}$ are difficult to measure. In that case, one may notice only the decrease in quality and may wrongly conclude that competition leads to inefficient outcomes.

**Case where the retailer has a comparative advantage in retailing**

The retailer’s efficiency advantage over the manufacturer in our model is based on the retailer’s higher marginal impact of effort on product quality. However we implicitly assume that, once product quality is determined, the manufacturer can run the retail store as efficiently as the retailer. Indeed, under integration, if bargaining breaks down, the manufacturer fires the retailer, runs the store on her own, and expects the same profits as if she had kept the retailer as employee. As a result, the retailer anticipates he will have zero bargaining power in renegotiation and thus has no incentives to exert effort. If we assume, instead, that the manufacturer cannot run the store as efficiently as the retailer, and that her alternative payoff is strictly less than the surplus from trade, then the retailer anticipates some ex post bargaining power and has more incentives to exert effort. In contrast, the manufacturer anticipates less ex post bargaining power and correspondingly weaker incentives. In fact, the larger the retailer’s comparative advantage in retailing, the higher the ratio of retailer effort to investor effort under integration. At the limit, if the retailer’s comparative advantage in retailing were so large that the manufacturer’s alternative payoff under integration were zero, then effort levels under integration would coincide with those under disintegration.

Under condition (1), a higher ratio of retailer effort to manufacturer effort leads to a net increase in quality and hence to a higher total surplus. A retailer’s comparative advantage in retailing would thus likely increase the net benefit from integration relative to that of disintegration (which stays constant), and this at any given degree of competition. The threshold levels of competition at which firms switch from integration to disintegration should therefore increase.

6. Concluding remarks

This paper studies the effects of competition on a manufacturer’s forward (dis)integration decision. The manufacturer must decide whether to have an integrated retail function or to operate through an independent retailer. By providing more incentives to the (efficient) retailer, vertical disintegration has the advantage of leading to higher-quality products. On the other hand, disintegration imposes a cost on the manufacturer in that it transfers ex post bargaining power to the retailer and forces her to forfeit part of the profits. We show that competition, through its business-stealing and rent-reduction effects, increases the manufacturer’s net benefit from disintegration.

Our model yields two primary implications. First, product market competition leads to vertical disintegration. Note that, even though in this model we have
focused on the manufacturer’s forward integration decision, the same implications would be obtained in an backward integration framework. We could indeed show that intensifying competition in the market for manufacturers’ products may push them towards outsourcing. These results are consistent with the empirical evidence documented in Coughlan (1985) and Holmes (1999). Coughlan, for example, finds a positive relationship between technology firms’ propensity to sell their technology via an independent middleman (disintegration) rather than via an integrated marketing channel and competition (measured by the degree of substitutability between products). 23 Second, competition leads to efficiency gains. We offer a new explanation for the relationship between competition and efficiency that is complementary to the ‘survivor principle’ and ‘managerial incentives’ explanations mentioned in the introduction. We argue that these efficiency gains are the result of organizational changes towards ‘leaner,’ more efficient, disintegrated vertical structures.

Another interesting prediction of the model is that, as competition intensifies, ‘weaker’ firms switch from integration to disintegration sooner than ‘stronger’ ones. 24 This may imply a sort of ‘herding’ behaviour (at moderate levels of competition): firms that have relatively strong (disintegrated) rivals may try to catch up by disintegrating as well, while firms that have weak (integrated) rivals have no incentives to become market leaders and remain integrated. In an environment with random shocks, for example, an industry may converge to an equilibrium where all firms disintegrate or to one where all firms integrate, depending on whether the initial shock promoted integration or disintegration. 25

The property rights theory of the firm, upon which our model is based, is notoriously difficult to test empirically (Whinston 2003). Importantly, however, our model could be tested against the alternative models of competition and integration described in the introduction, which yield different empirical predictions. For instance, in Bonanno and Vickers (1988), Rey and Stiglitz (1995), Gal-Or (1999), and Chen (2001, 2005), disintegration tends to be associated with efficiency losses, which occur through higher prices and lower output. In contrast, the efficiency gains present here occur through quality increases, with no quantity distortions. 26

23 Holmes (1999), finds that firms that are more geographically concentrated tend to outsource more of their inputs. Interestingly, Holmes interprets the results in terms of scale and vertical structure. That is, regions of greater scale allow specialized producers to form and hence will tend to be less vertically integrated. However, an equally valid interpretation would be in the light of this paper: higher geographic concentration implies greater competition among manufacturers, which in turn implies more disintegration (outsourcing).

24 The comparison between stronger and weaker firms is in terms of product quality and (consequently) market share.

25 This ‘herding’ behaviour may help us to understand the difference in vertical structure observed between the United States and Japan or between South Korea and Taiwan, for example. The United States and South Korea are much more integrated than Japan and Taiwan, respectively (McLaren 2000).

26 The implications of our model also contrast with those of Grossman and Helpman (2002). For example, while disintegration leads to more incentives and investment by the retailer in our
In order to offer a simple intuition, our model abstracts from important aspects of vertical integration. For example, we ignore investments in human capital (which are emphasized in the standard GHM approach) and focus instead on investments in physical capital (product quality). It would be interesting to analyse how the effects of competition on vertical structure depend on the relative types of investment (human or physical).27 Another caveat of the model is that it assumes that the two manufacturer-retailer supply chains are completely independent and does not allow cross selling by manufacturers. Here, we focus on product market competition and ignore competition in the input market and the related literature on foreclosure and extension of market power.28 Although the introduction of input competition in our model of product market competition is beyond the scope of this paper, future research in this largely unexplored area would be valuable.

Appendix

Proof of lemma 1

Consider any technology \( q(f, e) \) and variables \( f_h, f_l, e_h, e_l \) that meet the conditions described in section 2.

Strategies for the manufacturer

Let \( \Delta q_1 = q_i(f_{ih}, e_i) - q_j \) be the difference in value created by firms \( i \) and \( j \) when manufacturer \( i \) chooses high effort, given \( e_i, e_j, f_j \). Similarly, let \( \Delta q_2 = q_i(f_{il}, e_i) - q_j \). Naturally, \( \Delta q_1 > \Delta q_2 \). Let \( \Pi_{12} = \pi_i(q_i(f_{ih}, e_i), q_j, t) - \pi_i(q_i(f_{il}, e_i), q_j, t) \). Using (2), we can write

\[
\Pi_{12} = \left[ \frac{\Delta q_1 - \Delta q_2}{3} + \frac{\Delta q_1^2 - \Delta q_2^2}{18t} \right] n = \frac{\Delta q_1 - \Delta q_2}{3} \left[ 1 + \frac{\Delta q_1 + \Delta q_2}{6t} \right] n.
\]

(A1)

We will show that for all \( t > t_0 \), \( \min \Pi_{12} > (\max \Pi_{12})/2 \). This in turn implies that there exists a value of \( k_{im} \) such that \( \min \Pi_{12} > k_{im} > (\max \Pi_{12})/2 \), that is, such that the manufacturer exerts high effort under integration, but low effort under disintegration.

framework, it leads to fewer incentives and less investment by the agent (the supplier) in Grossman and Helpman. Other contrasts between the empirical predictions of their ‘Williamsonian’ (1985) approach and our ‘property rights’ approach are discussed in Whinston (2003).

27 In the extreme case in which the manufacturer and retailer invest only in human capital, since in our model the manufacturing and retailing assets are strictly complementary, then, as noted in Hart (1995), integration would always dominate disintegration and competition would have no effect on vertical structure. When the retailer invests at least partially in physical capital, however, integration no longer necessarily dominates.

28 For recent work on the topic, see Chen (2001), Chemla (2003), and de Fontenay and Gans (2005). See also Rey and Tirole (2003) for an excellent review.
Given the symmetry between firms $i$ and $j$, we must have either $\Delta q_1 > 0$ and $\Delta q_2 \geq 0$, or $\Delta q_1 \leq 0$ and $\Delta q_2 < 0$. Let $\Delta q_1(+) > 0$ and $\Delta q_2(+) \geq 0$. Obviously, in that case $\Pi_{12}$ strictly decreases with $t$, and $\Pi_{12}$ is maximized when $t \to \ell$. In that case $\lim_{t \to \ell} \Pi_{12}(+) \leq \max[q_i - q_j]$. When $t$ tends to infinity, $\Pi_{12}$ tends to $[(\Delta q_1 - \Delta q_2)/3]n$.

Now consider $\Delta q_1(-) \leq 0$ and $\Delta q_2(-) < 0$. In that case, $\Pi_{12}$ strictly increases with $t$, and tends to $[(\Delta q_1 - \Delta q_2)/3]n$ when $t$ tends to infinity. Thus, $\Pi_{12}(-)$ is minimized when $t \to \ell$; and $\lim_{t \to \ell} \Pi_{12}(-) > [(\Delta q_1(-) - \Delta q_2(-))/3](2n/3)$.

Thus, we can write that $\max \Pi_{12} < [(\Delta q_1(+) - \Delta q_2(+)}/3] (4n/3)$, and also that $\min \Pi_{12} > [(\Delta q_1(-) - \Delta q_2(-))/3] (2n/3)$.

Since for any given $e_i, \Delta q_1(+) - \Delta q_2(+) = \Delta q_1(-) - \Delta q_2(-) = q_i(f_{ih}, e_i) - q_i(f_{ih}, e_i)$, for all $t > \ell$ there exists a value of $k_{im} = [(q_i(f_{ih}, e_i) - q_i(f_{ih}, e_i))/3] \times (2n/3)$ such that $\min \Pi_{12} > k_{im} > (\max \Pi_{12})/2$, that is, such that the manufacturer exerts high effort under integration but low effort under disintegration.

**Strategies for the retailer**
Let $\Delta q_3 = q_i(f_i, e_{ih}) - q_j$, be the difference in value created by firms $i$ and $j$ when manufacturer $i$ chooses high effort, given $e_i, e_j, f_i, e_i$. Similarly, let $\Delta q_4 = q_i(f_i, e_{ih}) - q_j$. Then, $\Delta q_3 > \Delta q_4$. Let $\Pi_{34} = \pi_i(q_i(f_i, e_{ih}), q_j, t) - \pi_i(q_i(f_i, e_{ih}), q_j, t)$. Using (2), we can write

$$\Pi_{34} = \left[\frac{\Delta q_3 - \Delta q_4}{3} + \frac{\Delta q_3^2 - \Delta q_4^2}{18t}\right]n = \frac{\Delta q_3 - \Delta q_4}{3} \left[1 + \frac{\Delta q_3 + \Delta q_4}{6t}\right]n.$$  

(A2)

Since $t > \max(|q_i - q_j|)$, we can write $\min \Pi_{34} > [(\Delta q_3(-) - \Delta q_4(-))/3] \times (2n/3) > 0$. Therefore there exists a value of $k_{ir}$ such that $\min (\Pi_{34})/2 > k_{ir}$, that is, such that the retailer exerts high effort under retailer control.

Thus, for all $t > \ell$, there exists a set of values for variables $f_{ih}, f_i, k_m, e_h, e_i, k_e$, such that (1) in the case of integration, high effort and low effort are strictly dominating strategies for the manufacturer and the retailer, respectively; and (2) in the case of disintegration, low effort and high effort are strictly dominating strategies for the manufacturer and the retailer, respectively.

**Proof of lemma 2**
We know from (4) that $\partial(\pi_{iD} - \pi_{iII})/\partial t = p_{iD}(\partial d_{iD}/\partial t) + (\partial p_i/\partial t)(d_{iD} - d_{iII})$. Using (2) we can rewrite this as

$$\partial \left[\frac{\pi_{iD} - \pi_{iII}}{n}\right]/\partial t = \left(t + \frac{(q_{iD} - q_{jI})}{3}\right)\left(-\frac{(q_{iD} - q_{jI})}{6t^2}\right)$$

$$+ \left(\frac{1}{2} + \frac{(q_{iD} - q_{jI})}{6t}\right) - \frac{1}{2},$$  

(A3)
where the first term represents the business-stealing effect, while the second measures the rent-reduction effect. It should be clear from (A3) that the business-stealing effect dominates, and after simplification we obtain \( \frac{\partial}{\partial t} \left[ \frac{(\pi_{iD} - \pi_{II})}{n} \right] = -\frac{(q_iD - q_{II})^2}{(18t^2)} < 0. \)

**Proof of lemma 3**

We know from (5) that \( \frac{\partial (\pi_{iDD} - \pi_{iID})}{\partial t} = -p_{iID}(\partial d_{iID}/\partial t) + (\partial p_i/\partial t)(d_{iDD} - d_{iID}). \) We can rewrite this as

\[
\frac{\partial}{\partial t} \left[ \frac{\pi_{iDD} - \pi_{iID}}{n} \right] = - \left( t + \frac{(q_iD - q_{jI})}{3} \right) \left( -\frac{(q_iD - q_{jD})}{6t^2} \right) + \left( \frac{1}{2} - \frac{1}{2} + \frac{(q_iD - q_{jD})}{6t} \right),
\]

(A4)

where again the first term represents the business-stealing effect, while the second measures the rent-reduction effect. It should be clear from (A4) that in this case the business-stealing effect is dominated because \( p_{iID} \) is not large enough. After simplification we obtain \( \frac{\partial}{\partial t} \left[ \frac{(\pi_{iDD} - \pi_{iID})}{n} \right] = \frac{(q_iD - q_{jD})^2}{(18t^2)} > 0. \)

**Proof of lemma 4**

If rival \( j \) chooses integration, that is, \( Y = I \), equilibrium qualities are equal \( (q_iI = q_{jI}) \) and the cost of disintegration for manufacturer \( i \) is \( \pi_{II}/2 = (tn/2)/2 \). Obviously, the cost of disintegration strictly increases with \( t \) and decreases with competition: \( \frac{\partial (\pi_{II}/2)}{\partial t} = n/4 \).

If rival \( j \) chooses disintegration, that is, \( Y = D \), the cost of disintegration for manufacturer \( i \) is \( \pi_{iID}/2 = [(q_iD - q_{jD})/3 + t][(1/2) + (q_iD - q_{jD})/6t](n/2) \). Differentiating with respect to \( t \), we obtain \( \frac{\partial (\pi_{iID}/2)}{\partial t} = (n/4) - ((q_iD - q_{jD})^2 n)/(36t^3) > 0 \) for all \( t > t \). Note also that \( \frac{\partial (\pi_{II}/2)}{\partial t} > \frac{\partial (\pi_{iID}/2)}{\partial t} \): the effect of competition on the cost of disintegration is higher when rival \( j \) chooses integration.

**Proof of proposition 1**

If rival \( j \) plays integration, \( i \)'s net benefit from disintegration can be obtained from (3) and expressed as follows:

\[
NB_{i/y=I} = \left[ \frac{1}{2} \left( \frac{\Delta q}{3} + \frac{\Delta q^2}{18t} \right) - \left( \frac{1}{22} - \frac{k_{im}}{2} \right) \right] n,
\]

(A5)

where \( \Delta q = q_D - q_I \). First, note that \( \frac{\partial NB_{i/y=I}}{\partial t} < 0 \): manufacturer \( i \)'s benefit increases and her cost decreases with competition; therefore, her net benefit from choosing disintegration strictly increases with competition. Let us compute the positive root of the equation \( NB_{i/y=I} = 0 \). Solving for \( t \), we obtain the positive
root \( t_I \) such that \( t_I = (\Delta q/3 + 2k_{im}) + (\sqrt{(\Delta q + 6k_{im})^2 + \Delta q^2})/3 \). Since \( NB_{i/y = I} \) is a continuous and strictly decreasing function of \( t \) over \( \Re^+ \), then we must have \( NB_{i/y = I} \geq 0 \) if and only if \( t \leq t_I \). As long as \( t < t_I \), given that rival \( j \) plays integration, it is optimal for player \( i \) to choose disintegration if and only if \( t \leq t_I \), that is, if the degree of competition is sufficiently intense.

If rival \( j \) plays disintegration, \( i \)'s net benefit from disintegration can be expressed as

\[
NB_{i/y = D} = \left[ \frac{1}{2} \left( \frac{\Delta q}{3} - \frac{\Delta q^2}{18t} \right) - \left( \frac{1}{2} \left( \frac{t}{2} - \frac{\Delta q}{3} + \frac{\Delta q^2}{18t} \right) - k_{im} \right) \right] n. \tag{A6}
\]

Differentiating with respect to \( t \) gives

\[
\frac{d (NB_{i/y = D})}{dt} = -\frac{1}{4} + \frac{\Delta q^2}{18t^2} < 0 \text{ iff } t > \frac{\sqrt{2}}{3} \Delta q. \tag{A7}
\]

Since \( t > (\Delta q\sqrt{2})/3 \), we know that \( NB_{i/y = D} \) strictly decreases with \( t \) for all \( t > t_I \) and only if \( t > (\Delta q\sqrt{2})/3 \). Note, however, that \( NB_{i/y = D} = 0 \) has a unique positive root at \( t_D = ((2\Delta q)/3 + 2k_{im}) + (\sqrt{(2\Delta q + 6k_{im})^2 - 1/2\Delta q^2})/3 \). It is important to note that

\[
\lim_{t \to t_I} NB_{i/y = D}(t) = \left[ -\max|q_i - q_j| \frac{\Delta q}{12} + \frac{\Delta q^2}{6 \max|q_i - q_j| + k_{im}} \right] n > 0, \tag{A8}
\]

since \( \max(|q_i - q_j|) \geq \Delta q \). Therefore, since \( NB_{i/y = D} \) is a continuous and strictly decreasing function of \( t \) over \( (t, \infty) \) and strictly positive when \( t \to t_I \), we have the following result: as long as \( t \leq t_D, NB_{i/y = D} \geq 0 \) for \( t \in (t, t_D] \), and \( NB_{i/y = D} < 0 \) for \( t \in (t_D, \infty) \).

Note that both \( t_I \) and \( t_D \) are strictly increasing function of \( k_{im} \), which itself is a strictly increasing function of the number of consumers \( n \) (see proof of lemma 1). Therefore, for any \( t = \max(|q_i - q_j|) \), if \( n \) is large enough, we must have \( t_I, t_D \geq t \). We assume that \( n \) is such that this is the case.

To prove that \( t_D > t_I \), we start by subtracting \( (A5) \) from \( (A6) \). We obtain

\[
NB_{i/y = D} - NB_{i/y = I} = \left[ (\Delta q/3)/2 - ((\Delta q^2)/18t)3/2 \right] n.
\]

It is easily shown that \( NB_{i/y = D} - NB_{i/y = I} > 0 \) if and only if \( t > \Delta q/2 \), which is the case for all \( t > t_I \), since \( \max(|q_i - q_j|) \geq \Delta q \). Since both \( NB_{i/y = D} \) and \( NB_{i/y = I} \) are strictly increasing functions of \( t \) over \( (t, +\infty) \), it must necessarily be that \( NB_{i/y = D} \) crosses the axis of abscissa at a larger value of \( t \) than \( NB_{i/y = I}: t_D > t_I \).
References


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