

Successive Monopolies with Endogenous Quality*

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Abstract

The problem of double marginalization is pervasive in vertical relationships between independent firms that possess market power. This paper analyzes which types of product such firms will provide compared to a vertically integrated firm. In the case of downstream investment, disintegrated firms unambiguously provide higher quality than an integrated firm, a result that contradicts the presumption of downstream moral hazard in the literature. In the case of upstream investment, on the other hand, quality may be higher or lower compared to an integrated firm, depending on preferences and technology. If demand happens to be linear, quality is unaffected by integration.

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1 Introduction

Vertical relationships between firms with market power suffer from what is often called double marginalization or successive monopoly pricing. In models that describe this phenomenon, a monopoly upstream manufacturer sells a product to a monopoly downstream retailer who in turn sells it to consumers. If either of the firms increases its price, this reduces final demand and hence profits of both firms. And as neither of them takes this negative externality on the other firm into account, prices are higher than they would be under a vertically integrated monopolist. This has led economists to view vertical mergers more favorable than horizontal ones which tend to increase prices.¹

As a remedy to double marginalization, several mechanisms have been proposed. Candidates that solve the pricing problem in simplistic settings are franchise fees or resale price maintenance (RPM). Upstream firms can, for instance, demand a fixed franchise fee from the downstream firm and then sell the product at marginal cost. As the downstream firm faces the true marginal costs, it will be setting the regular monopoly price which maximizes joint profits.

However, in more complex surroundings involving uncertainty or asymmetric information, such schemes lose some of their bite. For one thing, they leave all potential risk with the downstream firm if demand is uncertain. The upstream firm, on the other hand, is fully insured against demand fluctuations. Transferring some of the risk to the upstream firm again involves a transfer price above marginal cost (Rey and Tirole, 1986). But even if it were optimal for the downstream firm to carry the whole risk², marginal cost pricing may not be feasible. To the extent that there

¹The first paper that formally showed how vertical integration generates a Pareto-superior allocation was Spengler (1950). But the basic insight that double marginalization is harmful was already contained in Cournot's (1838) analysis of horizontal pricing.

²Indeed, in many situations it seems more likely that the upstream firm should be exposed to most of the risk; e.g., if the upstream monopolist is a large producer that can diversify across sales regions, while there are several small downstream retailers that have local monopolies.

is asymmetric information between upstream and downstream firm concerning future demand conditions, pricing above marginal cost will be necessary. If the upstream firm knows more about demand than the downstream firm (due to marketing research, say), then it will have to signal its knowledge by increasing the transfer price and lowering the fixed fee relative to first best levels (Gallini and Wright, 1990). A similar result obtains if the downstream firm has private information about demand (due to local knowledge, say). See Tirole (1988, p. 176-177) for a discussion and further arguments why a franchise fee and RPM in general will not make it possible to make the downstream firm full residual claimant.

These theoretical arguments for the pervasiveness of double marginalization are endorsed by real world contracts which often display retail prices that are significantly higher than marginal cost. Since, therefore, double marginalization is an important phenomenon, it is useful to ask in which way its occurrence influences the business strategies of vertically related firms as opposed to integrated ones. This paper analyzes what type of products successive monopolies will supply. In particular, it highlights what type of quality successive monopolists provide relative to an integrated monopolist.

This question has first been raised by Economides (1999). He investigates the case where the following three conditions are fulfilled: (i) firms set prices simultaneously, (ii) the qualities provided by the two firms are perfect complements (i.e., $q = \min\{q_1, q_2\}$), and (iii) quality costs are fixed. In this setting, independent firms provide less quality than an integrated firm. This result is driven by the fact that providing quality has the nature of a public good here: improving overall quality allows both firms to charge higher prices. Hence, too little of it will be provided in a non-cooperative environment. While the case Economides analyzes is very interesting (the leading example being telecommunications), it clearly does not capture the features of most instances of double marginalization. Typically, we would have a situation in mind where (i) firms are

ordered vertically, implying that firm 2 can make her mark-up contingent on firm 1's price, (ii) different qualities are substitutable, and (iii) the provision of quality increases the marginal costs of production. This is the case that is analyzed in this paper. As it turns out, the results then crucially differ from Economides's.

This paper differentiates between three situations. First, the case of downstream investment (Section 3) where only the second firm invests in quality. Second, the case of upstream investment (Section 4) where only the first firm invests in quality. And finally, the general case in which both upstream and downstream firm provide quality improvements (Section 4 also).³

The main results of the paper are the following. In the case of downstream investment, disintegrated firms unambiguously provide higher quality than an integrated firm. To see the intuition behind this result, note that an independent producer faces higher input prices than an integrated firm, because an independent input supplier will sell his inputs above marginal costs. An increase in input costs will lead a monopolist to contract output. That is, the product is sold to a more exclusive segment of consumers. This, however, makes it profitable to increase quality, as these customers have a higher willingness to pay for luxury goods. As Section 3 discusses, this result stands in sharp contrast to the presumption of downstream moral hazard that is discussed in the literature (e.g., Tirole, 1988).

In the case of upstream investment, on the other hand, quality may be higher or lower compared to an integrated firm, depending on preferences and technology. Here, two effects are at work. As double marginalization drives prices up, the first effect is again that investing in quality becomes more lucrative. This is the way the upstream firm can *use* the unfortunate presence of pricing externalities. But since the investing firm now moves first, it can also try to *reduce* the extent of double-marginalization by preventing the downstream firm from setting a mark-up that would

³As will be demonstrated below, the results in this case are simply driven by a combination of the effects of upstream and downstream investment.

restrict output excessively. In order to do so, the upstream firm reduces the quality of its product, making it unattractive for the downstream firm to target only the wealthy segment of demand. In essence, the upstream firm chooses to produce a mass product in order to prevent the downstream firm from selling it as a luxury good. It turns out that these two opposing effects exactly offset each other when demand is linear, in which case two separate firms provide exactly the same level of quality as an integrated monopolist.

Concerning welfare analysis (Section 5), it is shown that an integrated monopolist provides too little quality in the setting of this paper. This observation implies that, whenever quality is higher under disintegration, there is a positive effect of disintegration on welfare (which is absent in standard models of vertical pricing). The paper goes on to show, however, that the negative welfare effect of double marginalization always dominates this potential positive effect; and, hence, vertical integration remains desirable from a social point of view even if a possible increase in quality is accounted for.

Finally, the results are extended to the case where firms can offer multiple products of differing quality (Section 6). In this setting, one can analyze how to optimally price-discriminate a discriminating monopolist. It turns out that the upstream firm will indeed try to alter the way in which the downstream firm discriminates. The intuition of the results go along the lines of the results for the single-product case, so that this exercise can be regarded as a generalization of the basic model. Section 7 concludes.

2 The model

Consider a market for a vertically differentiated product which is characterized by its quality q . Consumers are of mass one and have a marginal willingness to pay for quality θ which, without loss

of generality, is distributed on $[0, 1]$ according to some cumulative distribution function $F(\theta)$ with corresponding density function $f(\theta)$.⁴ Accordingly, a consumer of type θ receives an (indirect) utility $U(p, q) = \theta q - p$ from consumption of the good at price p . Consumers will buy whenever they receive positive utility which is the case whenever $\theta \geq p/q$. Hence, demand is given by $D(p, q) = 1 - F(p/q)$.

The distinguishing feature of the assumption of a constant marginal willingness to pay for quality is that consumers with a higher absolute willingness to pay for quality also have a higher marginal willingness to pay for it. This is the standard single crossing property which makes much intuitive sense in the present context.

Goods are produced in a vertical production process which consists of a monopoly upstream firm (indexed by 1) that produces an intermediate good and a monopoly downstream firm (indexed by 2) that uses the intermediate good to produce a final good which it sells to consumers. This vertical chain may or may not be integrated. The overall quality of the final good is given by $q = \alpha q_1 + (1 - \alpha)q_2$, where $\alpha \in [0, 1]$ is a measure of the relative importance of the upstream investment. Clearly, the quality levels provided by the two firms are substitutes here (in contrast to Economides, 1999, where qualities are complements). Producing quality levels q_1 and q_2 gives rise to marginal costs of $\alpha c_1(q_1)$ for the upstream firm and $(1 - \alpha)c_2(q_2)$ for the downstream firm, where I assume that $c_1(\cdot)$ and $c_2(\cdot)$ are strictly convex and fulfill the Inada conditions. Hence, quality costs are proportional to the importance of quality. This formulation ensures that a change in α does not influence the optimal choice of quality of an integrated monopolist, which allows us to trace back changes in the quality provision of independent firms that a change in α may induce to strategic considerations. It would be possible to add fixed costs (or, more generally,

⁴Obviously, the model encompasses supports other than the chosen one by appropriately transforming the distribution function on θ . One can think of different θ 's as belonging to different individuals, implying that every consumer has unit demand, or, alternatively, as the different marginal valuations arising from multiple consumption.

increasing returns to scale) to the model without altering the quality of the results but I will not do so here.⁵ Finally, denoting the transfer price of the intermediate good as p_1 and the mark-up of the downstream firm as p_2 , we have $p = p_1 + p_2$.⁶

For expositional reasons, a simple two type model will be presented in the main body of the text, while Appendix A analyzes the general case and proves all propositions for arbitrary type distributions. For the time being, assume that there exist only two potential valuations θ_H and θ_L with $\theta_H > \theta_L$, $f(\theta_H) = \gamma$, and $f(\theta_L) = 1 - \gamma$. Accordingly, we will say that demand is "weak" if γ is small and that demand is "strong" if γ is large.

3 Downstream investment

If one thinks of vertical relationships among firms, two major cases come to mind: the producer/retailer relationship and the intermediate/final good producer relationship. The former can be (and has been extensively) analyzed within the scope of the classical literature on vertical contracting. The latter, on the other hand, can only be treated appropriately in a model that explicitly models the process of refinement. This section is an attempt to do so. Let $\alpha = 0$, i.e., there is a homogeneous intermediate good. This input will then be processed by the downstream firm which decides on the level of quality q_2 .

As a benchmark, let us first investigate the optimal price/quality bundle an integrated monopolist would provide. As there are only two types, the question is whether she should sell to the entire market or just to high types (high types always being ready to buy a product that low types are willing to buy).

⁵The quality of the results *would* be affected if fixed costs were to depend on q . See Section 7 for a discussion.

⁶In Sections 3 and 4 it will be assumed that firms can only offer one product at one price—an assumption that is relaxed in Section 6.

The highest price that allows the firm to cover the whole market is $p = \theta_L q$. This gives a profit of $\theta_L q - c_2(q)$, which is maximized at $c_2'(q) = \theta_L$. Defining $\psi_i(q)$ as the inverse function of $c_i'(q)$, $i = 1, 2$, we therefore have $q = \psi_2(\theta_L)$ and $p = \theta_L \psi_2(\theta_L)$.⁷ This gives a profit of

$$\Pi^{all} = \theta_L \psi_2(\theta_L) - c_2(\psi_2(\theta_L)). \quad (1)$$

Alternatively, the monopolist can sell only to high types. The highest price she can demand then is $p = \theta_H q$. This gives a profit of $\gamma[\theta_H q - c_2(q)]$, which is maximized at $q = \psi_2(\theta_H)$. Then $p = \theta_H \psi_2(\theta_H)$ and profit is

$$\Pi^{high} = \gamma[\theta_H \psi_2(\theta_H) - c_2(\psi_2(\theta_H))]. \quad (2)$$

Comparing (1) and (2) we find that selling to the whole market is optimal if and only if

$$\gamma \leq \frac{\theta_L \psi_2(\theta_L) - c_2(\psi_2(\theta_L))}{\theta_H \psi_2(\theta_H) - c_2(\psi_2(\theta_H))}. \quad (3)$$

Let us define the value of γ for which (3) holds with equality as γ^I . It is easy to check that it is optimal to cover a large market whenever demand is weak (i.e., γ is small) or if preferences are homogeneous (i.e., $\theta_H - \theta_L$ is small).

Next, we turn to the situation where upstream and downstream firm are not integrated. In this case, the downstream firm can buy the intermediate good from the upstream firm at price p_1 . In principle, the downstream firm then stands in front of the same decision as the integrated monopolist: should I cover the whole market or only high types?

⁷Such an inverse always exists due to the convexity of the $c_i(\cdot)$, $i = 1, 2$. Note that the chosen quality is exactly at the level that low types would choose if they owned the production facilities. This is a general property: as Spence (1975) and Sheshinski (1976) have shown, a monopolist will always provide the quality level that the marginal consumer desires—disregarding the preferences of intramarginal consumers.

The maximum price that can be charged from low types is $p_2 = \theta_L q_2 - p_1$. Choosing q_2 to maximize the resulting profit of $\theta_L q_2 - p_1 - c_2(q_2)$ gives $q_2 = \psi_2(\theta_L)$ and hence $p = \theta_L \psi_2(\theta_L)$. The profit then amounts to

$$\Pi_2^{all} = \theta_L \psi_2(\theta_L) - p_1 - c_2(\psi_2(\theta_L)). \quad (4)$$

If the downstream firm decides to sell only to high types, her price can be augmented to $p_2 = \theta_H q_2 - p_1$. Accordingly, profits are given by $\gamma[\theta_H q_2 - p_1 - c_2(q_2)]$, which have a maximum at $q_2 = \psi_2(\theta_H)$. Therefore, $p = \theta_H \psi_2(\theta_H)$ and

$$\Pi_2^{high} = \gamma[\theta_H \psi_2(\theta_H) - p_1 - c_2(\psi_2(\theta_H))]. \quad (5)$$

Comparing (4) and (5), we find that that selling to the whole market is optimal if and only if

$$p_1 \leq \frac{1}{1-\gamma} [\theta_L \psi_2(\theta_L) - c_2(\psi_2(\theta_L))] - \frac{\gamma}{1-\gamma} [\theta_H \psi_2(\theta_H) - c_2(\psi_2(\theta_H))]. \quad (6)$$

Note also that the downstream firm will only be willing to buy the input at all if her profit from (5) is non-negative, which is the case if and only if⁸

$$p_1 \leq \theta_H \psi_2(\theta_H) - c_2(\psi_2(\theta_H)). \quad (7)$$

That is, the upstream firm, in the first stage of the game, can decide on the final allocation by either choosing a low transfer price (such that (6) is binding) or a high transfer price (such that

⁸It can be easily verified that if p_1 is such that profit is positive in (5), then, a fortiori, it is positive in (4).

(7) is binding). In the former case, the whole market is covered and her profits are given by

$$\Pi_1^{all} = \frac{1}{1-\gamma} [\theta_L \psi_2(\theta_L) - c_2(\psi_2(\theta_L))] - \frac{\gamma}{1-\gamma} [\theta_H \psi_2(\theta_H) - c_2(\psi_2(\theta_H))]. \quad (8)$$

In the latter case, only high types are served and we have

$$\Pi_1^{high} = \gamma [\theta_H \psi_2(\theta_H) - c_2(\psi_2(\theta_H))]. \quad (9)$$

A simple comparison of (8) and (9) shows that serving the entire market is more profitable if and only if

$$2\gamma - \gamma^2 \leq \frac{\theta_L \psi_2(\theta_L) - c_2(\psi_2(\theta_L))}{\theta_H \psi_2(\theta_H) - c_2(\psi_2(\theta_H))}. \quad (10)$$

We will define the value of γ for which (10) holds with equality as γ^{NI} . Comparing the outcome under successive monopolies with the one under an integrated monopolist, we then have the following proposition.

Proposition 1 *Compared to a vertically integrated monopolist, successive monopolies with downstream investment (i) demand a higher price, (ii) produce a higher quality, (iii) serve a more exclusive class of consumers, and (iv) provide the amount of quality that maximizes joint profits for the given output.*

Proof: Rearranging (10) yields $(\gamma^{NI})^2 - 2\gamma^{NI} + \gamma^I = 0$. Acknowledging that γ is between zero and one, this has the unique solution $\gamma^{NI} = 1 - \sqrt{1 - \gamma^I}$. We will show that $\gamma^{NI} \leq \gamma^I$. Assume otherwise. Then it must be that $1 - \sqrt{1 - \gamma^I} > \gamma^I$, that is, $1 - \gamma^I > \sqrt{1 - \gamma^I}$. But this is a contradiction to $\gamma^I \in [0, 1]$. If $\gamma \leq \gamma^I$ or $\gamma \geq \gamma^I$, prices and qualities of the two regimes are identical. If $\gamma \in (\gamma^I, \gamma^{NI})$, however, we have $p = \theta_L \psi_2(\theta_L)$ and $q = \psi_2(\theta_L)$ in the case of

integration, whereas $p = \theta_H \psi_2(\theta_H)$ and $q = \psi_2(\theta_H)$ in the case of successive monopolies. That is, price and quality are strictly higher under non-integration. This proves (i) and (ii). (iii) is obvious and (iv) follows from the fact that p/q is equal to the valuation of the marginal consumer in all cases. ■

Proposition 1 has a very simple intuition. In the case of successive monopolists, the downstream firm faces a maximization problem that is perfectly analogous to the maximization problem of an integrated monopolist—except that she has to incur higher costs for the intermediate good, which the upstream firm sells above marginal costs in order to make profits.⁹ The natural response of any monopolist to increasing marginal costs is, of course, to contract output. Hence, we have a more exclusive marginal consumer and therefore it is profitable to increase product quality. In short, double marginalization drives prices up and this makes it more lucrative to tailor the product to the needs of the upper segment of demand.

Up to now, we have interpreted the case of downstream investment as a situation where a producer buys an intermediate good from an input supplier and then refines it in order to create a final product. Another obvious interpretation of the model is where we consider the upstream firm to be a producer of a homogeneous good and the downstream firm to be a retailer that provides services. In general, an upstream producer will worry that the retailer does not put enough effort into these promotional activities. This problem has been termed downstream moral hazard. Tirole (1988) shows that—when choosing the promotional effort—the retailer exerts a positive externality on the producer (increased services lead to higher demand for the producer’s products). As the retailer does not fully internalize this externality, however, the provided service quality is too low given the input price.

⁹In the situation that is considered here, marginal costs are zero as the upstream firm provides no quality. Nonetheless, she asks for a strictly positive price.

The existence of this quality-reducing externality and the term "moral hazard" make it tempting to suspect that in such a situation an independent retailer provides less services than an integrated monopolist would. After all, a monopolist will take the total effect of service provision on profits into account, i.e., there will be no moral hazard. This contention is wrong. As Proposition 1 shows, quite to the contrary, independent retailers provide *more* services than an integrated firm would. What went wrong in the above analysis? The analytical trap here is that there is a negative externality on the upstream firm *only if we are taking the input price as given*. However, it does not make much sense to take the pricing of the first mover as given since it is already chosen strategically in order to influence the response of the second mover. In particular, an upstream firm chooses a price above marginal costs in order to appropriate as much rent from the downstream firm as possible. If, to the contrary, it were to ask only for its production costs, then the downstream firm would indeed choose final price and quality such that joint profits are maximized. Hence, one could even argue that the party who is exerting moral hazard here is the upstream firm, really. As Proposition 1 shows, the retailer at least chooses a level of promotional effort that is optimal for joint profits *taking the group of buyers as given*. In any case there is no reason to worry that retailers with market power would provide low levels of services in a market with double marginalization.

4 Upstream investment

While Section 3 was concerned with downstream investment, this section analyzes the opposite extreme of upstream investment, that is, $\alpha = 1$. This specification is descriptive of a standard producer/retailer relationship when the provision of promotional activities by the retailer is not a great concern. The main conceptual difference to the case of downstream investment is that the investing firm can now directly influence the pricing behavior of the other firm by selecting a

particular level of quality.

For reasons of comparison, we will again want to know the optimal price/quantity combination of a vertically integrated monopolist. This is simply given by the integrated monopoly solution of the previous chapter, where we change indices from 2 to 1 where appropriate, because investments are now taken at the upstream stage. For later reference, let us denote the analog to γ^I as $\tilde{\gamma}^I$.

When there is no integration, the downstream firm again has to decide whether to cover the whole market or not. Apparently, the highest price it can post without losing customers is $p_2 = \theta_L q_1 - p_1$, which results in a profit of $\theta_L q_1 - p_1$. If it decides to sell only to high types, it can demand a price of $p_2 = \theta_H q_1 - p_1$, which yields a profit of $\gamma[\theta_H q_1 - p_1]$. Accordingly, covering the entire market is more profitable if and only if¹⁰

$$p_1 \leq \frac{\theta_L - \gamma\theta_H}{1 - \gamma} q_1. \quad (11)$$

As in Section 3, the downstream firm will only be willing to sell if profits are non-negative, which is the case here if and only if

$$p_1 \leq \theta_H q_1. \quad (12)$$

At stage 1, the upstream firm decides on the level of quality and the transfer price p_1 . Obviously, only the two price levels for which (11) and (12) hold binding are adequate. Choosing the lower price gives a profit of $\tilde{\theta}q_1 - c_1(q_1)$ which is maximal at $q_1 = \psi(\tilde{\theta})$. This gives a price of

¹⁰For notational simplicity, let us denote the right hand side of (11) as $\tilde{\theta}$. It is easily shown that $\tilde{\theta} < \theta_L$ for all $\gamma \in (0, 1)$.

$p = \theta_L \psi(\tilde{\theta})$ and, thus, a profit of

$$\Pi_1^{all} = \tilde{\theta} \psi_1(\tilde{\theta}) - c_1(\psi_1(\tilde{\theta})). \quad (13)$$

Choosing the higher price—and, hence, rationing low types—gives a profit of $\gamma[\theta_H q_1 - c_1(q_1)]$. The optimal level of quality is then given by $q_1 = \psi_1(\theta_H)$. Consequently, we have $p = \theta_H \psi_1(\theta_H)$ and

$$\Pi_1^{high} = \gamma[\theta_H \psi_1(\theta_H) - c_1(\psi_1(\theta_H))]. \quad (14)$$

Comparing (13) and (14), we find that covering the whole market is optimal if and only if

$$\gamma \leq \frac{\tilde{\theta} \psi_1(\tilde{\theta}) - c_1(\psi_1(\tilde{\theta}))}{\theta_H \psi_1(\theta_H) - c_1(\psi_1(\theta_H))} \quad (15)$$

The level of γ that holds (15) binding will be denoted as $\tilde{\gamma}^{NI}$. Now we are ready to state Proposition 2.

Proposition 2 *Compared to a vertically integrated monopolist, successive monopolies with upstream investment (i) demand a higher price (if demand is strong) or a lower price (if demand is weak), (ii) produce a higher quality (if demand is strong) or a lower quality (if demand is weak), (iii) serve a more exclusive class of consumers, and (iv) provide too little quality relative to the amount that maximizes joint profits for the given output.*

Proof: We will again start by showing that $\tilde{\gamma}^{NI} \leq \tilde{\gamma}^I$. This follows simply from the fact that $\tilde{\theta} < \theta_L$. This already establishes (iii). Next, we observe that the allocations are identical if $\gamma \geq \tilde{\gamma}^I$. Simple inspection shows that prices are higher under an integrated monopolist when $\gamma < \tilde{\gamma}^{NI}$, while they are (weakly) lower otherwise. This proves (i). A similar comparison leads to

(ii). Finally, if $\gamma \geq \tilde{\gamma}^{NI}$, we have $q_1 = \psi_1(\theta_H)$, i.e., quality is optimal for the marginal consumer H . If $\gamma < \tilde{\gamma}^{NI}$, however, $q_1 = \psi_1(\tilde{\theta}) < \psi_1(\theta_L)$, i.e., quality is too low for the marginal consumer L . ■

The driving forces behind Proposition 2 are two separate effects. One of them is already known from Section 3: as double marginalization increases prices for a given level of quality, the upstream firm has an incentive to increase quality since it now has a more exclusive clientele. In contrast to Section 3, however, there is a second effect at work also. This is because the upstream firm can not only react to the existence of double marginalization, but can actively influence its extent by choosing the level of quality. The appropriate thing to do for the upstream firm is to reduce quality, as this makes it less tempting for the downstream firm to contract output (which is the essence of double marginalization). The upstream firm effectively produces a mass product (in terms of quality) in order to hinder the downstream firm from marketing it as a luxury good.

It is noteworthy that the latter effect introduces an inefficiency regarding quality provision that is captured by Proposition 2 (iv). The upstream firm's behavior here is akin to what a social planner does in a second best world: when there is a distortion in one dimension of the market (here the price-distortion caused by double marginalization), it becomes optimal to introduce a distortion in a second dimension (here by reducing quality). Note also that the quality-reducing effect may be so strong that successive monopolists will demand a *lower* price than an integrated monopolist despite the presence of double marginalization.

The above analysis shows that the quality independent firms provide may be higher or lower than the quality an integrated firm would provide, depending on the strength of two opposing effects. Therefore, we may ask ourselves whether the resulting total effect is economically significant or rather negligible. In order to do that, it is useful to look at the more general model of continuous types which is analyzed in Appendix A. There, I prove the following proposition.

Proposition 3 *If market demand is linear in the price, then successive monopolies with upstream investment will always provide the same amount of quality as an integrated monopolist.*

That is, in the special case of linear demand (but for arbitrary cost functions $c_1(\cdot)$), the two opposing effects on quality exactly offset each other. Hence, to the extent that market demand can be approximated by a linear function in the relevant range, we come to the conclusion that concerns about product quality are unjustified in the analysis of vertical mergers in markets with upstream investment. In this case, merger analysis should therefore focus on other issues as pricing, efficiency, and the possibility of predatory behavior.

5 Welfare analysis

In order to evaluate the welfare effects of successive monopolies, it is instructive to start with an evaluation of the welfare properties of the equilibrium under integrated monopoly. A quality-supplying monopolist behaves suboptimal in two distinct ways. First, as was already mentioned above, she is only concerned with marginal consumers but not with intramarginal ones. In the setting of this model, people with a higher willingness to pay for a given good also have a higher willingness to pay for quality increases. Hence, all intramarginal consumers find quality too low. That is, *taking the set of consumers as given*, a monopolist supplies too little quality. In addition to that, a monopolist creates the usual welfare loss caused by output contraction.¹¹

What does vertical disintegration add to this? A first consequence of independent monopolies is double marginalization, which causes a further output contraction, adding to the welfare loss. On a second count, however, it has been shown that disintegration may increase quality provision. That, again, is welfare enhancing because intramarginal consumers receive a level of quality that

¹¹Taking the two effects together, monopoly quality may be too high or too low compared to the first best.

is closer to their personal optimum.

Unfortunately, Proposition 4 demonstrates that the negative welfare effect always dominates the potentially positive effect of a change in quality; and, hence, vertical integration remains desirable from a social point of view even if a possible increase in quality is accounted for.

Proposition 4 *Both in the case of downstream investment and in the case of upstream investment, welfare is unambiguously higher under integration than under non-integration.*

Proof: In the case of downstream investment, only if $\gamma \in (\gamma^{NI}, \gamma^I)$ can there be a difference between the two regimes. Here, $q^I = \psi_2(\theta_L)$ and $q^{NI} = \psi_2(\theta_H)$. Denoting total welfare by W we have $W^I = \bar{\theta}\psi_2(\theta_L) - c_2(\psi_2(\theta_L))$ and $W^{NI} = \gamma[\theta_H\psi_2(\theta_H) - c_2(\psi_2(\theta_H))]$. Accordingly, $W^I \geq W^{NI}$ is equivalent to

$$\gamma \leq \frac{\bar{\theta}\psi_2(\theta_L) - c_2(\psi_2(\theta_L))}{\theta_H\psi_2(\theta_H) - c_2(\psi_2(\theta_H))}, \quad (16)$$

where $\bar{\theta} = \gamma\theta_H + (1 - \gamma)\theta_L$. This condition is implied by $\gamma < \gamma^I$. Repeating these steps for the case of upstream investment (the relevant case being $\gamma \in (\tilde{\gamma}^{NI}, \tilde{\gamma}^I)$) again yields condition (16) which is implied by $\gamma < \tilde{\gamma}^I$. Hence the result. ■

6 Extension: price discrimination

7 Conclusion

This paper has shown that the quality provision of vertically related firms may depend on whether or not there is vertical integration. In the case of downstream investment, independent firms provide a higher amount of quality than an independent monopolist, an observation that is at odds with the presumption of downstream moral hazard. Furthermore, quality provision is unaffected

in the case of upstream investment with linear demand. Thus, if anything, quality is likely to be higher under disintegration.

These results are largely at odds with Economides's (1999) who finds that successive monopolies provide lower quality than an integrated firm. Therefore, it is useful to investigate what drives this difference in results. As far as quality provision is concerned, Economides's paper differs from this one in two crucial ways. First of all, he assumes that firms first simultaneously choose their quality levels and set their mark-ups p_1 and p_2 simultaneously in a second stage. In such a setup, *both* firms' returns to quality investments are subject to expropriation from the other firm, not just the first mover's. Hence, both will be reluctant to invest. In which industries the pricing structure is sequential rather than simultaneous is of course an empirical question. It seems fair to say, however, that a sequential structure is more descriptive of most instances of double marginalization.¹²

A second aspect of Economides (1999) that tends to reduce the quality provisions of firms is the cost of quality in his model. Remember that this paper has adopted the view that an increase in quality increases marginal rather than fixed costs. This implies that quality has no scale effects. I.e., what type of quality a firm wants to supply is determined by the preferences of its consumers and not by (dis-)economies of scale. In general, however, it may of course be that high quality production is more efficient on a large or on a small scale. Fixed costs that increase with quality (as in Economides, 1999) tend to make production of luxury goods for the upper segment of demand unprofitable. Double marginalization reduces quantities, which makes luxury production more expensive in this model due to the fixed cost assumption. This means that—even though a firm serves more exclusive customers—it will be reluctant to increase product quality. Whether this is a reasonable assumption or not clearly depends on the the industry at hand. This

¹²However, in long distance telecommunications, for example, a simultaneous pricing game is clearly more appropriate, as different companies serve their local customers.

paper has taken the view that it is unclear whether there are (dis-)economies of scale in quality provision. The assumption of constant returns has the obvious advantage that it clearly works out the strategic reasons for quality changes in different structural regimes. It is, of course, simple to add, say, fixed costs that increase with quality to the model. In this case, there is an additional quality reducing effect that has to be traded off against the two effects that drive the results in Section 3 and 4 of the paper.

8 Appendix

Note: This appendix is utterly incomplete and not brought in order. Update with complete proofs soon.

Successive monopolies:

Marginal profits: $\pi_1 = p_1 - \alpha c_1(q_1)$ and $\pi_2 = p_2 - (1 - \alpha)c_2(q_2)$

Total profits: $\Pi_i = D(p, q)\pi_i$

Integrated monopoly:

Marginal (=average) profits: $\pi = \pi_1 + \pi_2$

Total profits: $\Pi = q\pi = \Pi_1 + \Pi_2 = q(\pi_1 + \pi_2)$

8.1 Downstream Investment

Assumption 1. $F(\theta)$ fulfills the monotone hazard rate property, that is $\frac{d[(1-F(\theta))/f(\theta)]}{d\theta} < 0$.

Assumption 1 implies

$$\frac{1 - F}{f} \frac{f'}{f} + 1 > 0 \quad (17)$$

$$\alpha = 0 \Rightarrow q_1 = 0$$

8.1.1 An integrated monopolist

Stage 2

$$\max_{p_2, q_2} \left[1 - F \left(\frac{p_1 + p_2}{q_2} \right) \right] (p_2 - c_2(q_2))$$

FOC wrt p_2 :

$$\frac{1 - F}{f} = \frac{\pi_2}{q_2} \quad (18)$$

FOC wrt q_2 :

$$\frac{1 - F}{f} = \frac{\pi_2}{q_2} \frac{p}{q_2 c_2'} \quad (19)$$

From (2) and (3) then

$$p = q_2 c_2' \Leftrightarrow c_2' = \theta^* \quad (20)$$

That is, the quality that is provided by the upstream firm is exactly the one that is optimal for the marginal consumer θ^* .¹³ Hence, everybody who purchases the good, except the marginal consumer, would prefer a higher quality.

Some second order partial derivatives:

$$\begin{aligned}\frac{\partial^2 \Pi_2}{\partial p_2^2} &= -\frac{f}{q_2} \left(\frac{f'}{f} \frac{\pi_2}{q_2} + 2 \right) \\ \frac{\partial^2 \Pi_2}{\partial q_2^2} &= -\frac{p}{q_2} \frac{f}{q_2} \left[\frac{f'}{f} \frac{p}{q_2} \frac{\pi_2}{q_2} + 2 \frac{\pi_2}{q_2} + 2c'_2 + (1-F) \frac{q_2^2}{p} c_2'' \right] \\ \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2} &= \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} = \frac{f}{q_2} \left(\frac{f'}{f} \frac{p}{q_2} \frac{\pi_2}{q_2} + \frac{\pi_2}{q_2} + c'_2 + \frac{p}{q_2} \right) \\ \frac{\partial^2 \Pi_2}{\partial p_2 \partial p_1} &= -\frac{f}{q_2} \left(\frac{f'}{f} \frac{\pi_2}{q_2} + 1 \right) \\ \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_1} &= \frac{f}{q_2} \left(\frac{f'}{f} \frac{p}{q_2} \frac{\pi_2}{q_2} + \frac{\pi_2}{q_2} + c'_2 \right)\end{aligned}$$

A critical point (p_2, q_2) characterized by (2) and (3) is a strict global maximizer of $\Pi_2(\cdot)$ whenever the Hessian

$$D^2 \Pi_2(p_2, q_2) = \begin{pmatrix} \frac{\partial^2 \Pi_2}{\partial p_2^2} & \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} \\ \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2} & \frac{\partial^2 \Pi_2}{\partial q_2^2} \end{pmatrix}$$

is negative definite. This is the case whenever the two leading principal minors of $D^2 \Pi_2$ alternate in sign. Hence, we must have

$$\left| \frac{\partial^2 \Pi_2}{\partial p_2^2} \right| < 0 \Leftrightarrow \frac{f'}{f} \frac{\pi_2}{q_2} + 2 > 0, \quad (21)$$

¹³The preferred quality of a consumer of type θ can be found by solving $\max_{q_1, q_2} \theta q - \alpha c_1(q_1) - (1-\alpha)c_2(q_2)$, which has $c'_i(q_i) = \theta$ for $i = 1, 2$ as its solution. The result that a monopolist provides the optimal quality for the marginal consumer is due to Spence (1975) and Sheshinski (1976).

which is implied by (1) and

$$\left| \begin{array}{cc} \frac{\partial^2 \Pi_2}{\partial p_2^2} & \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} \\ \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2} & \frac{\partial^2 \Pi_2}{\partial q_2^2} \end{array} \right| > 0 \Leftrightarrow \frac{\partial^2 \Pi_2}{\partial p_2^2} \frac{\partial^2 \Pi_2}{\partial q_2^2} - \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2} > 0 \quad (22)$$

(6) can be shown to be true if and only if

$$c_2'' > \frac{\pi_2/q_2}{\left(\frac{f'}{f} \frac{\pi_2}{q_2} + 2\right) q_2} > 0. \quad (23)$$

(7) clearly holds if $c_2(q_2)$ is sufficiently convex, which I will assume to be the case.

From (2), (3), and the implicit function theorem

$$\frac{dp_2}{dp_1} = - \frac{\left| \begin{array}{cc} \frac{\partial^2 \Pi_2}{\partial p_2 \partial p_1} & \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2} \\ \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_1} & \frac{\partial^2 \Pi_2}{\partial q_2^2} \end{array} \right|}{\left| \begin{array}{cc} \frac{\partial^2 \Pi_2}{\partial p_2^2} & \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2} \\ \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} & \frac{\partial^2 \Pi_2}{\partial q_2^2} \end{array} \right|} = - \frac{\frac{\partial^2 \Pi_2}{\partial p_2 \partial p_1} \frac{\partial^2 \Pi_2}{\partial q_2^2} - \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_1} \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2}}{\frac{\partial^2 \Pi_2}{\partial p_2^2} \frac{\partial^2 \Pi_2}{\partial q_2^2} - \left(\frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2}\right)^2} \quad (24)$$

With a little algebra, using (2), (4), and (6) it can be shown that $dp_2/dp_1 > -1$ (possibly even > 0) and hence

$$\frac{dp}{dp_1} = \frac{dp_2}{dp_1} + 1 > 0. \quad (25)$$

Furthermore,

$$\frac{dq_2}{dp_1} = - \frac{\begin{vmatrix} \frac{\partial^2 \Pi_2}{\partial p_2^2} & \frac{\partial^2 \Pi_2}{\partial p_2 \partial p_1} \\ \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} & \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_1} \end{vmatrix}}{\begin{vmatrix} \frac{\partial^2 \Pi_2}{\partial p_2^2} & \frac{\partial^2 \Pi_2}{\partial p_2 \partial q_2} \\ \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} & \frac{\partial^2 \Pi_2}{\partial q_2^2} \end{vmatrix}} = - \frac{\frac{\partial^2 \Pi_2}{\partial p_2^2} \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_1} - \frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} \frac{\partial^2 \Pi_2}{\partial p_2 \partial p_1}}{\frac{\partial^2 \Pi_2}{\partial p_2^2} \frac{\partial^2 \Pi_2}{\partial q_2^2} - \left(\frac{\partial^2 \Pi_2}{\partial q_2 \partial p_2} \right)^2} > 0 \quad (26)$$

where the inequality can again be shown by using (2), (4), and (6).

Finally,

$$\frac{d(p/q)}{dp_1} = \frac{1}{q_2} \left(1 + \frac{dp}{dp_1} - \frac{dq_2}{dp_1} \right) > 0 \quad (27)$$

where we have again used (2), (4), and (6).

Stage 1

$$\max_{p_1} \left[1 - F \left(\frac{p_1 + p_2(p_1)}{q_2(p_1)} \right) \right] [p_2(p_1) + p_1 - c_2(q_2(p_1))]$$

FOC wrt p_1

$$\frac{1 - F}{f} = \frac{1 + \frac{dp_2}{dp_1} - \frac{dq_2}{dp_1} \frac{p}{q_2} \pi}{1 + \frac{dp_2}{dp_1} - \frac{dq_2}{dp_1} c_2' q_2}$$

Using (4) this gives

$$\frac{1 - F}{f} = \frac{\pi}{q_2} \quad (28)$$

(11) and (2) together yield $\pi_2 = \pi$ and hence we must have

$$p_1 = 0$$

as could be expected. Since the upstream unit does not produce, it demands no internal price from the downstream unit, in order to cause no distortion in the downstream unit's price setting.

8.1.2 Successive monopolies

Stage 2 remains unchanged.

Stage 1

$$\max_{p_1} \left[1 - F \left(\frac{p_1 + p_2(p_1)}{q_2(p_1)} \right) \right] p_1$$

Proposition 5 *Compared to a vertically integrated monopolist, successive monopolies with downstream investment (i) demand a higher price p , (ii) produce a higher quality q , (iii) serve a more exclusive class of consumers (i.e., the marginal consumer has a higher valuation θ), and (iv), taking the marginal consumer as given, the provided quality is profit maximizing (i.e., $c'(q) = \theta^*$).*

Proof. *First, we will show that under successive monopolies $p_1 > 0$. (To be done)*

Now (i) simply follows from (9), (ii) from (10), (iii) from (11), and (iv) from (iv) ■

8.2 Upstream investment

$$\alpha = 1 \Rightarrow q_2 = 0$$

8.2.1 An integrated monopolist

Stage 2

$$\max_{p_2} \left[1 - F \left(\frac{p_1 + p_2}{q_1} \right) \right] p_2$$

FOC

$$\frac{1 - F}{f} = \frac{p_2}{q_1} \quad (29)$$

SOC

$$\frac{f'}{f} \frac{p_2}{q_1} + 2 > 0 \quad (30)$$

(19) follows from (1) and (18).

From the implicit function theorem and (18) we have

$$\frac{dp_2}{dp_1} = -\frac{\frac{\partial^2 \Pi_2}{\partial p_2 \partial p_1}}{\frac{\partial^2 \Pi_2}{\partial p_2^2}} = -\frac{\frac{f'}{f} \frac{p_2}{q_1} + 1}{\frac{f'}{f} \frac{p_2}{q_1} + 2} \in (-1, 0) \quad (31)$$

Hence,

$$\frac{dp}{dp_1} = 1 + \frac{dp_2}{dp_1} = \frac{1}{\frac{f'}{f} \frac{p_2}{q_1} + 2} \in (0, 1) \quad (32)$$

Again from the implicit function theorem and (18)

$$\frac{dp_2}{dq_1} = -\frac{\frac{\partial^2 \Pi_2}{\partial p_2 \partial q_1}}{\frac{\partial^2 \Pi_2}{\partial p_2^2}} = \frac{\frac{p}{q_1} \left(\frac{f'}{f} \frac{p_2}{q_1} + 1 \right) + \frac{p_2}{q_1}}{\frac{f'}{f} \frac{p_2}{q_1} + 2} = \frac{p_2}{q_1} - \frac{p_1}{q_1} \frac{dp_2}{dp_1} \in (0, 1) \text{ and } < \frac{p}{q_1} \quad (33)$$

Then

$$\frac{d(p/q)}{dp_1} = \frac{dp}{dp_1} \frac{1}{q_1} = \frac{1}{q_1} \frac{1}{\frac{f'}{f} \frac{p_2}{q_1} + 2} > 0$$

and

$$\frac{d(p/q)}{dq_1} = -\frac{1}{q_1} \frac{p_1}{q_1} \frac{dp}{dp_1} = -\frac{p_1}{q_1} \frac{d(p/q)}{dp_1} = -\frac{1}{q_1} \frac{p_1}{q_1} \frac{1}{\frac{f'}{f} \frac{p_2}{q_1} + 2} < 0$$

Stage 1

$$\max_{p_1, q_1} \left[1 - F \left(\frac{p_1 + p_2(p_1, q_1)}{q_1} \right) \right] [p_1 + p_2(p_1, q_1) - c_1(q_1)]$$

FOC wrt p_1

$$\frac{1 - F}{f} = \frac{\pi}{q_1} \quad (34)$$

FOC wrt q_1

$$\frac{1 - F}{f} = \frac{\frac{dp_2}{dq_1} - \frac{p}{q_1} \pi}{\frac{dp_2}{dq_1} - c'_1} \frac{\pi}{q_1} \quad (35)$$

From (23) and (24)

$$p = q_1 c'_1 \Leftrightarrow c'_1 = \theta^* \quad (36)$$

From (23) and (18) $p_2 = \pi$ and hence

$$p_1 = c_1$$

That is, again, the downstream monopolist makes zero profits so as to maximize the overall profit of the firm.

8.2.2 Successive Monopolies

Stage 2 is like in the integrated monopoly case.

Stage 1

$$\max_{p_1, q_1} \left[1 - F \left(\frac{p_1 + p_2(p_1, q_1)}{q_1} \right) \right] [p_1 - c_1(q_1)]$$

FOC wrt p_1

$$\frac{1 - F}{f} = \left(1 + \frac{dp_2}{dp_1} \right) \frac{\pi_1}{q_1} \quad (37)$$

FOC wrt q_1

$$\frac{1-F}{f} = \left(\frac{p}{q_1} - \frac{dp_2}{dq_1} \right) \frac{\pi_1}{q_1 c'_1} \quad (38)$$

(27) and (28) give

$$\frac{p}{q} = \frac{dp}{dp_1} c'_1 + \frac{dp_2}{dq_1} \quad (39)$$

Using (21) and (22) we have

$$p_1 = q_1 c'_1 \quad (40)$$

As $p_2 > 0$ (will be shown below) thus

$$c'_1 < \theta^*, \quad (41)$$

i.e., given θ^* , successive monopoly supplies too low quality relative to the profit maximizing amount.

(27) and (18) give¹⁴

$$p_2 = \left(1 + \frac{dp_2}{dp_1} \right) \pi_1 \quad (42)$$

With (21) then

$$p_2 = \frac{\pi_1}{\frac{f'}{f} \frac{p_2}{q_1} + 2} \quad (43)$$

Likewise, (28) and (18) give

$$p_2 = \left(\frac{p}{q_1} - \frac{dp_2}{dq_1} \right) \frac{\pi_1}{c'_1} > 0 \quad (44)$$

¹⁴As $p_2 = \pi_2$ and $\frac{dp}{dp_1} \in (0, 1)$ it follows that $\pi_1 > \pi_2$.

as $\frac{p}{q_1} - \frac{dp_2}{dq_1} > 0$ from (17). With (22)

$$p_2 = \frac{\pi_1}{\frac{f'}{f} \frac{p_2}{q_1} + 2 q_1 c_1'} \frac{p_1}{c_1'} \quad (45)$$

Case 1: $q^I \leq q^{NI}$

Case 2: $q^I > q^{NI}$

Proposition 6 *Suppose the externality-effect outweighs the commitment-effect. Then, compared to a vertically integrated monopolist, successive monopolies with upstream investment (i) demand a higher price, (ii) produce a higher quality, (iii) serve a more exclusive class of consumers, and (iv), taking the marginal consumer as given, the provided quality is below the profit maximizing amount.*

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