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Single Monopoly Profits, Vertical Mergers, and Downstream Entry Deterrence

Matthias Hunold* and Jannika Schad*

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Abstract

We review the Chicago school's *single monopoly profit* theory whereby an upstream monopolist cannot increase its profits through vertical integration as it has sufficient market power anyways. In our model the dominant supplier has full bargaining power and uses observable two-part tariffs. We show that, by vertically integrating with a downstream incumbent, the supplier can profitably commit to pricing more aggressively if a downstream entrant refuses its supply contract. This can deter welfare-enhancing entry. The anti-competitive effects arise from the seemingly pro-competitive elimination of double marginalization. We relate our model to hybrid platforms and, in particular, Apple's App store.

JEL classification: L22, L40, L42
Keywords: double marginalization, entry deterrence, exclusive dealing, foreclosure, vertical merger

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1 Introduction

The effects of vertical integration on the market outcome are a key issue in competition policy. Proponents of the Chicago School argue that full vertical mergers enhance efficiency and, at worst, have neutral effects on competition (e.g., Bork, 1978; Posner, 1979). More recent theories based on richer models highlight both the beneficial and socially detrimental effects of vertical integration. Game theoretic models reveal anti-competitive effects of vertical integration under specific conditions, such as additional commitment power of the integrated firm (Ordover *et al.*, 1990), secret contract offers (Hart and Tirole, 1990), and the cost of switching suppliers (Chen, 2001).[1] We show that vertical integration can also deter entry, and thereby foreclose the market, in a basic setting where these conditions do not apply. Our analysis of entry deterrence thereby contributes to the literature on market foreclosure.[2]

Our model features an efficient supplier with market power, an established downstream firm, and a (potential) symmetric downstream entrant. The upstream firm offers observable contracts with two-part tariffs to the active downstream firm(s). Figure 1.1 illustrates the baseline model with an unconstrained ("*pure*") upstream monopoly, consistent with the *single monopoly profit theory*.

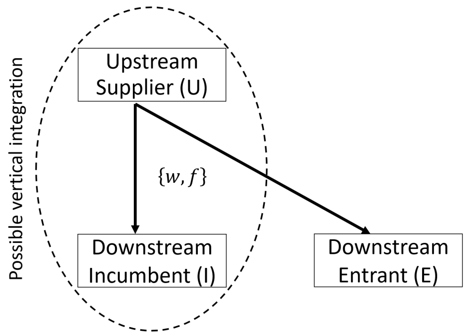

Figure 1.1: Framework with incumbents – both upstream and downstream – as well as a potential downstream entrant. The dashed circle indicates the possible merger of the incumbents, w the per-unit price, and f the upfront fee of the two-part tariff.

The upstream firm offers each independent downstream firm a contract with a unit price and a fixed fee that leaves the downstream firm indifferent to not being active on the market. The downstream firms accept the tariff in equilibrium. Adverse effects of vertical integration on entry incentives are not obvious here. The upstream firm can extract the downstream profits with the fixed fee of the two-part tariff so that the participation constraint binds. The downstream entrant will thus only get a profit equal to its exogenous outside option, irrespective of whether the upstream firm is vertically integrated with the established downstream firm. The incentives to enter the market hence seem to be unaffected by the vertical integration. With observable contracts, the upstream monopolist faces no commitment problem and implements unit wholesale prices that lead to downstream monopoly prices. This is consistent with the *single monopoly profit* theory whereby vertical integration cannot increase profits beyond the monopoly level.

[1]Other notable assumptions include input choice specifications (Choi and Yi, 2000), two-part tariffs (Sandonís and Faulí-Oller, 2006), exclusive dealing contracts (Chen and Riordan, 2007), upstream collusion (Normann, 2009), only integrated upstream firms (Bourreau *et al.*, 2011), and non verifiable input quality (Allain *et al.*, 2015).

[2]Foreclosure refers to the situation that actual or potential rivals' access to supplies or markets is hampered or eliminated, thereby reducing these companies' abilities and/or incentives to compete (European Commission, 2008).

A vertical merger may even be pro-competitive by reducing double marginalization in the case of observable two-part tariff offers when there is downstream competition.[3] This can arise when the upstream firm charges independent downstream firms unit prices above costs to account for the competitive downstream margins. With vertical integration, the upstream firm can increase the unit price only for the non-integrated firm. As it is typically assumed in the vertical relations' literature, within the integrated firm, downstream pricing is based on the true upstream costs (see, e.g., Assumption 1 in Hart and Tirole (1990)). Vertical integration may thus reduce the downstream price level compared to a situation without vertical integration. In any case, independent downstream firms make profits equal to their exogenous outside options and thus do not suffer from vertical integration of rivals.

We contribute by showing that once we add (potential) competition through a less efficient fringe at the upstream level, as depicted in Figure 1.2, the incumbent firms can deter entry through vertical integration. This result seems counter-intuitive as the fringe should restrain the upstream supplier in its input pricing. However, with an alternative input supply, the outside option value of the downstream entrant does depend on whether there is vertical integration of the established downstream and upstream firms. The outside options are thus *endogenous* and depend on the upstream market structure and prices.

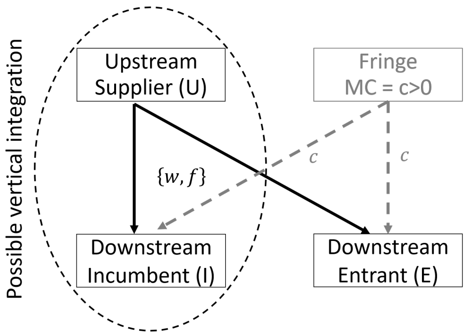

Figure 1.2: Framework with a less efficient upstream fringe competitor that sells its input at marginal costs of c to the downstream firms.

Importantly, in our model the less efficient alternative supply source is never actually used in the market. For our results it is only necessary that the downstream firms can ramp up an alternative supply (e.g., less efficient in-house production) if they cannot agree on a contract with the efficient supplier.[4] The market may therefore look equivalent to one with a *pure* upstream monopoly. In particular, the market outcome of our setting is that all downstream firms source exclusively from the efficient supplier who faces no opportunism problem and has a market share of 100%. Moreover, the alternative source may be relatively inefficient, such that the efficient upstream firm may be able to earn high margins – like a monopolist. This resembles a market where an observer – for instance a competition authority – might think that Chicago School's *single monopoly profit* theory could apply, such that vertical integration would not raise

[3] Contract observability means that, when deciding, which supply contract to accept, even the non-integrated downstream firms know what input contracts have been offered to their competitors. Observability results from restricting the upstream firm's offers to be uniform (non-discriminatory) between the independent downstream firms but can also be assumed explicitly for the case of (possibly) non-uniform contract offers.

[4] An example of a firm that detached itself from a vertical dependency by establishing an integrated substitute is the Schwarz Group, the parent company of the Lidl and Kaufland supermarket chains. The Schwarz Group is the first retailer to establish a vertically integrated dual system in Germany. The dual systems organize the collection, sorting and recycling of waste generated in industry and commerce. Before the new foundation, there were nine such systems — all without a link to retailing (see, e.g., the article in manager magazin from 01 October 2018 on "Lidl-Mutterkonzern gründet eigenes duales System"; last access on 2021/08/16).

competitive concerns. However, in this setting, this is wrong.

When there is the possibility of an alternative input supply, we present the following theory of harm for the case of *observable* two-part tariff offers: Vertical integration eliminates the double marginalization of the integrated firms, such that the entrant, when not purchasing from the integrated unit, competes against a firm that sets downstream prices based on the true input costs. Instead, with vertical separation of the established firms, the entrant competes against a firm that has a unit input price above the true upstream costs.[5] Consequently, the entrant faces a more aggressive competitor and thus makes lower profits with vertical integration of the established firms. Depending on the costs of entering the market, this can deter entry and thus foreclose the market.

The elimination of double marginalization acts as a commitment to intense downstream competition when the entrant does not source the inputs from the efficient upstream firm. While the elimination of double marginalization is often seen as an important pro-competitive effect of vertical integration, it is actually the reason for anti-competitive concerns in the present case. The result is intriguing as the outcome in the same setting but without a fringe supply is consistent with the *single monopoly profit* theory. In that theory the dominant supplier can use complex tariffs to extract any economic profits from independent downstream firms – with and without vertical integration, such that there is no effect on the entry incentives.

The article proceeds as follows. We review the related literature in section 2. We present the model in section 3 and solve it for the case of observable two-part tariff offers with both quantity as well as price competition in section 4 and conduct a welfare analysis.

In section 5, we relate our model to the case of Spotify who filed a complaint in March 2019 regarding preferencing of Apple's integrated Apple Music App in the App Store. As the commission fees in the App Store are based on a revenue share, we show that equivalent results arise when the two-part tariff has a revenue share instead of a per-unit price, provided that the downstream firms have positive marginal production costs.

In section 6, we provide additional analyses. We review the complementary findings of Rey and Tirole (2007) for secret contracting where, due to the opportunism problem, the *single-monopoly profit* theory does not apply. Rey and Tirole illustrate briefly that vertical integration can reduce an independent downstream firm's profit in the case of a competitive fringe supply (section 6.1). We show that the finding crucially depends on the assumptions of quantity competition as well as interim unobservability and illustrate that opposite implications arise either under price competition or interim observability of the sourcing decisions. In particular and surprisingly, we illustrate that in the setting presented by Rey and Tirole (2007), vertical integration can be pro-competitive by increasing the entry profits in the case of price competition.

In section 6.2, we allow for an ex-ante commitment of the efficient supplier to not deal with the entrant. We show that exclusive dealing also reduces the incentives of entry in most cases, and, therefore, could be a substitute to vertical integration. However, in particular when there is downstream price competition, vertical integration tends to be more deterrent than exclusive dealing. Our analysis suggests that vertical integration as a structural measure may be credible (less adjustable) and thus more effective than an exclusive dealing contract for the purpose of deterring entry.

Section 7 concludes with a summary and policy conclusions. Overall, these analyses comple-

[5] We demonstrate that this is always the case for imperfect price competition under mild assumptions on demand and also the case for quantity competition when the alternative upstream supply is not too efficient.

ment our analysis of oberservable tariffs and emphasizes that the nature of the supply contracts between up- and downstream firms as well as the type of competition (price versus quantity) can matter for the competitive effects of vertical mergers.

2 Related literature

In this section we present related literature in addition to the foreclosure literature that we already cited in the introduction.

Related framework. Our article relates to Sandonís and Faulí-Oller (2006) who analyze the competitive effects of vertical integration by a research laboratory. Our model is similar to theirs and they also relate their analysis to market foreclosure (we look at the special case of entry deterrence). However, while they consider two downstream incumbents, we focus on downstream entry into a monopoly market. The differences in the framework result in different effects and policy implications. For instance, we find that entry deterrence through vertical integration is always to the detriment of welfare, whereas, for an exogenous market structure, vertical integration reduces welfare only if upstream competition is sufficiently intense. We discuss the differences in more detail in section Appendix B.

Chicago School. Our article links to theories formulated by proponents of the (Post-) Chicago School. See Riordan (2008) for a summary. According to the Chicago School's *single monopoly profit* theory, an upstream monopolist, which can use contracts to extract all monopoly profits from the downstream firms, cannot generate additional profits through vertical integration (e.g., Bork, 1978). Vertical integration would, thus, not have the objective of *leveraging monopoly power* and thus should also not foreclose markets.

In our framework, the efficient supplier and the downstream monopolist can jointly obtain monopoly profits when no entry occurs. As in the *single monopoly profit* theory, vertical integration does not change the total profit obtained by the involved firms. In line with the Chicago School*'s eliminating markups* theory, the efficient upstream firm chooses a contract that prevents the emergence of excessive double marginalization.

In our framework, once we add the possibility of alternative sourcing in the downstream market, vertical integration becomes an instrument to retain monopoly profits through entry deterrence.[6] Note that there is a strategic incentive for double marginalization, even with two-part tariffs, when there is downstream competition and the contract offers are observable. However, vertical integration eliminates double marginalization for the integrated chain of firms. In contrast to the general perception that the elimination of double marginalization is pro-competitive, we show that the elimination of double marginalization can also be anti-competitive as it leads to more aggressive downstream competition, which can deter entry of an efficiency-enhancing firm.

Secret contracting and opportunism. Whereas our main analysis focuses on the case of non-secret tariff offers, we also study secret contracting and the opportunism problem in section

[6] Alternative sourcing means that firms can produce the inputs less efficiently in-house or purchase them from a less-efficient competitive fringe.

6.1. This relates to the theory summarized under the name *restoring monopoly power* in Riordan (2008). This theory mainly deals with the commitment problem whereby an upstream monopolist cannot extract the monopoly profits from the downstream firms due to its opportunistic behavior (Hart and Tirole, 1990).[7] Crucial assumptions for the commitment problem are secret bilateral contracts, non-linear contracts, and no multilateral commitment power of the upstream firm.

It is well known, at least since Hart and Tirole (1990), that in the simple framework with a downstream duopoly that produces homogeneous goods, vertical integration restores the monopoly power of the upstream firm by fully foreclosing the separated firm. When products are differentiated, a vertically integrated firm does not fully foreclose the separated firm. However, vertical integration now solves the commitment problem by creating a situation with complete information; it becomes common knowledge that the monopolist sells input at marginal cost to its subsidiary (compare Rey and Tirole, 2007, p. 32–33, for the case of homogeneous goods).

Reisinger and Tarantino (2015) show that vertical integration under secret two-part tariffs with a less efficient retailer can be procompetitive. The reason is output shifting: The integrated monopolist has an incentive to give the more efficient and separated retailer a unit cost price below marginal cost, thus shifting output from the less efficient to the efficient retailer.

Rey and Tirole (2007) provide a short analysis of upstream competition through a less efficient firm that offers inputs at marginal cost for the case of secret contracting.[8] Vertical integration now leads to partial foreclosure of the separated downstream firm and, depending on the form of competition, decreases or increases the separated firm's outside option profit. This result is complementary to our analysis of non-secret two-part tariffs. Rey and Tirole (2007) only analyze the case of quantity competition and interim-unobservability in their overview article. We extend their analysis to price competition as well as interim observability in section 6 and demonstrate that the foreclosure results crucially depend on these assumptions. In that section, we also highlight how the foreclosure effects differ between secret and observable two-part tariff offers.

Exclusive dealing. Apart from vertical integration, exclusive dealing can as well result in entry deterrence (see e.g., Aghion and Bolton (1987) and Fumagalli and Motta (2006)). In Aghion and Bolton (1987), two vertically-related firms use exclusive dealing to decrease the entry incentives and make themselves better off. The incumbents employ exclusive dealing to mainly obtain a share of the surplus that the entrant generates if entering the supplier's market. Their exclusive contract creates entry costs and entry depends on the efficiency of the entrant.[9] While in some sense similar in spirit to our article, there are also essential differences. Our incumbents use vertical integration to prevent entry in the downstream market and retain the monopoly profit. Vertical integration in our case does not entail any exclusivity. Entry deterrence occurs because there is contracting with externalities and vertical integration changes the marginal input costs of the downstream incumbent. This decreases the entrant's profits post-entry. We

[7] That is, to capture residual demand, the monopolist has an incentive to give a variable cost advantage to the last firm that enters into a contract. The firms with the cost disadvantage anticipate the opportunistic behavior of the monopolist and refuse to accept the monopolizing contracts. Instead of monopoly prices, the monopolist charges marginal cost.

[8] See section 2.2 on page 32 in Rey and Tirole (2007).

[9] Entry costs either take the form of waiting costs, namely the entrant needs to wait until the contract expires or the entrant pays liquidated damages if the retailer breaks the contract to trade with the entrant.

show in an extension that a commitment to exclusive dealing of the efficient upstream supplier can also have entry deterring effects similar to vertical integration but tends to be less deterrent.

Fumagalli and Motta (2006) also look at entry deterrence in the upstream market under exclusive contracts. They show that if competition is fierce enough in the downstream market, the incumbent upstream firm will not employ exclusive contracts to prevent entry.

3 Model

There are two downstream firms with index $i \in \{I, E\}$, one is the incumbent firm I and the other a potential entrant E. They produce substitutes. We study the game for both downstream price and quantity competition and denote the general demand and inverse demand functions by $q_i(p_i, p_{-i})$ and $p_i(q_i, q_{-i})$ with $i \neq -i \in \{I, E\}$.

The downstream firms need homogeneous inputs; they transform the input 1:1 into output at zero marginal cost. Supplier U produces the inputs at marginal costs of zero. The downstream firms can alternatively obtain the inputs at marginal costs of $c > 0$. One can think of this less efficient source as either in-house production or a competitive fringe supply. For a small enough c, U is restricted in its pricing. For a large enough c, U is an unconstrained monopolist.

The timing is as follows:

1. U and I decide whether to merge or to stay separate.
2. E decides whether to become active at a fixed cost $\theta > 0$.
3. U offers a uniform two-part tariff, comprising a fixed fee f and a unit input price w, to all independent and active downstream firms and, in case of vertical integration, provides the input at marginal cost to firm I.
4. Each active and separate downstream firm either accepts or rejects the contract offer.
5. All active downstream firms set their downstream price p_i or quantity q_i (we study both cases).

For the main analysis in section 4, we assume that actions of the previous stages are common knowledge and solve the game by backward induction. The assumption of a uniform (that is: non-discriminatory) two-part tariff in stage 3 already implies observability of the contract terms. [10] As all independent downstream firms are symmetric post-entry, assuming a uniform two-part tariff is equivalent to allowing for discriminatory tariffs and explicitly assuming contract observability in stage 4.[11] Thus, the assumption of a uniform tariff is – in our case – without loss of generality and simplifies the notation.

We denote equilibrium outcomes with the superscripts M for monopoly, D for duopoly, I for integration, and S for separation. For instance, $\left\{w^{DS}, f^{DS}\right\}$ denotes the equilibrium tariff for the case of entry and vertical separation whereas $\left\{w^{DI}, f^{DI}\right\}$ denotes the equilibrium tariff for a downstream duopoly in the vertically integrated case.

[10] When a downstream firm knows its own contract offer and knows about uniform pricing, it can directly infer the contract terms offered to the competitor. The assumption of uniform pricing is also used in related models, such as Caprice (2006) and Hunold (2020).

[11] The equilibrium offers turn out to be symmetric with observable contracts. Exclusion of one downstream firm by making asymmetric offers with one being effectively no offer is not optimal as (i) either there is an alternative supply source that this downstream firm would use or (ii) if there is no efficient enough alternative supply source, the upstream firm can extract all profits from the downstream firm. The assumption of observable two-part tariffs has been used in similar models (e.g., Hunold and Stahl (2016)).

Profits. For the profit of the up- and downstream firms, we use the following notation:

- $\Pi_U(w)$ denotes the profit of supplier U in case of vertical separation as a function of the unit input price w.
- Π_i denotes the profit of downstream firm i.
- Π_{UI} denotes the profit of the vertically integrated firms U and I.

The downstream firms are symmetric apart from E's cost of entry. The entrant E only enters when its post-entry profit is larger than or equal to its entry cost of θ. One can think of the entry cost as a random variable from the perspective of the established firms, such that entry is more (less) likely when the post-entry profits of the entrant are higher (lower). We use the following notation for the outcomes of stage 5.

- Denote by $\widetilde{q}(x, y)$ and $\widetilde{p}(x, y)$ the reduced-form quantities and prices as a function of the downstream firm's own unit input cost x and the unit input cost y of its competitor.
- Denote by $\pi(x, y)$ a downstream firm's profit before the fixed fee with x and y defined as above.

For these functions, we denote the case where the entrant is not active by setting its unit input costs to ∞.

Assumption 1. *The reduced-form up- and downstream profits are, twice differentiable and strictly concave, such that the relevant first-order conditions characterize stable equilibria.*

In particular, for comparative statics, we also make

Assumption 2. *The profit of a downstream firm depends negatively on its own input cost* $(\partial\pi(x, y)/\partial x < 0)$ *and positively on the input cost of its competitor* $(\partial\pi(x, y)/\partial y > 0)$. *The profit decreases when all input cost increase:* $\partial\pi(x, y)/\partial x + \partial\pi(x, y)/\partial y < 0$.

For price competition, we specifically impose

Assumption 3. *Downstream firm i's quantity in the subgame of stage 5 increases when the marginal input costs y of the downstream competitor −i increase:* $\frac{\partial q_i}{\partial p_i}\frac{\partial \widetilde{p}(x,y)}{\partial y} + \frac{\partial q_i}{\partial p_{-i}}\frac{\partial \widetilde{p}(x,y)}{\partial x} > 0$.

All these assumptions hold with linear demand as specified below.

Parametric demand based on a linear quadratic utility function. We characterize results in terms of general demand and profit functions as far as possible. While we derive central results with reduced-form demand functions where possible, we use a parametric demand function for certain results and illustrations. We derive the parametric demand functions from the linear-quadratic utility

$$u(q_I, q_E) = q_I + q_E - \frac{q_I^2}{2} - \frac{q_E^2}{2} - \gamma q_I q_E \tag{3.1}$$

as in Sandonís and Faulí-Oller (2006).

Parameter γ measures the degree of substitutability between the products and ranges from $\gamma = 0$ for independent products to $\gamma = 1$ for perfect substitutes.[12] The representative consumer

[12]The value of $\gamma = 1$ is excluded for price competition. In this case, there would be perfect competition with zero profits for the entrant post-entry, such that the entry incentives do not depend on vertical integration.

maximizes $u(q_i, q_{-i}) - \Sigma_{i=I,E}\, p_i q_i$ with respect to q_i, where q_i is the amount that the consumer purchases from firm i and p_i the respective price.[13] Utility maximization implies the inverse linear demand function for product i of

$$1 - q_i - \gamma q_{-i} \tag{3.2}$$

and the parametric demand function for product i of

$$\frac{1 - p_i - \gamma + \gamma p_{-i}}{1 - \gamma^2}. \tag{3.3}$$

Welfare is given by

$$W(q_I, q_E) = u(q_I, q_E) - \theta \cdot I(\text{entry}), \tag{3.4}$$

where the indicator $I(entry)$ is one in the case of downstream entry and zero otherwise.[14] For the case of price competition, we restrict attention to imperfect substitutes ($\gamma < 1$) to obtain continuous reaction functions.

4 Main analysis

4.1 Pricing and output decisions (stages 3 to 5)

Downstream monopoly (no entry) and vertical separation. Absent entry, the independent downstream incumbent maximizes its profit

$$\Pi_I = (p_I - w)\, q_I - f$$

by setting either the monopoly price $p_I = \widetilde{p}(w, \infty)$ or the quantity $q_I = \widetilde{q}(w, \infty)$, which depend on the unit input price w. Recall that we set the entrant's cost to ∞ when the entrant is not active.

Under vertical separation, supplier U maximizes

$$\Pi_U(w) = \{w \cdot \widetilde{q}(w, \infty) + f\} \tag{4.1}$$

with respect to w and f, subject to the downstream incumbent's participation constraint

$$\underbrace{\pi(w, \infty)}_{\text{flow profit}} - f \geqslant \underbrace{\pi(c, \infty)}_{\text{outside option profit}}.$$

The flow profit on the left – which the incumbent obtains when buying from U – has to be larger than or equal to its outside option on the right, which is the profit that I obtains when sourcing alternatively at marginal costs of c.

For a given unit price w, supplier U chooses a fixed fee f, such that the above participation constraint binds:

[13] The demand functions derived from the underlying utility function in equation (3.1) allows for a consistent analysis of entry where another, possibly differentiated product becomes available. They also allow for an expansion of demand thereby preventing an underestimation of the entrant's incentive to enter (Höffler, 2008; Levitan and Shubik, 1971).

[14] To be precise, the quantity of input produced by the alternative supply source at the inefficiently high cost of c also enters the welfare function. However, in all equilibria, we will obtain that this quantity is zero. We therefore abstract from it in the welfare function.

$$f = \pi(w, \infty) - \pi(c, \infty). \quad (4.2)$$

The equilibrium profit of I thus equals its outside option profit of $\pi(c, \infty)$. The efficiency of the alternative therefore determines the share of the monopoly profit that the downstream incumbent can keep.

As U extracts the residual downstream profit through the fixed fee, it maximizes the industry profit. This profit is maximized when the unit price equals marginal cost. Consequently, the equilibrium two-part tariff is given by

$$\left\{w^M, f^M\right\} = \{0, \pi(0, \infty) - \pi(c, \infty)\}.$$

Lemma 1. *Under vertical separation and without downstream entry, the downstream monopolist obtains a profit $\pi(c, \infty)$ equal to its outside option.*

Downstream monopoly (no entry) and vertical integration. Vertical integration is profitable for U and I when their joint profit post-merger exceeds their joint profits prior to the merger. Absent entry, the incumbents jointly earn monopoly profits both under vertical separation and vertical integration and cannot increase their joint profits through integration.

Lemma 2. *Absent entry, the incumbents jointly earn monopoly profits irrespective of their integration decision and are indifferent between integration and separation.*

Downstream duopoly (entry) and vertical separation. Supplier U extracts all profits from the two downstream firms through the fixed fee, except for their outside option values. For this case the assumption of a uniform input tariff matters as it implies that the tariff offers are observable to the downstream firms in stage 4. This eliminates the opportunism problem, which can arise under secret tariffs (see section 6.1).

With downstream competition, a downstream firm's profit when sourcing alternatively equals $\pi(c, w)$ and depends on the input price of the competitor. The unit input cost of the competitor is w. The outside option profit is reached through a unilateral deviation from the equilibrium path where both downstream firms buy from supplier U based on the uniform two-part tariff (w, f).[15]

Supplier U maximizes

$$\Pi_U = \sum_{i \in \{I, E\}} \left(w \cdot \tilde{q}(w, w) + \underbrace{\pi(w, w) - \pi(c, w)}_{\text{fixed fee}} \right) \quad (4.3)$$

with respect to w.

Without a relevant outside option (c large enough), the outside option profits are zero ($\pi(c, w) = 0$) and the profit in equation (4.3) equals the industry profit. With downstream competition, the industry profit is maximized at a unit input price above marginal costs in order to induce the downstream firms to set prices at the monopoly level.

With relevant outside options, U can extract more profits from the downstream firms when their outside option profit $\pi(c, w)$ is low. The supplier thus has an incentive to set w below the

[15] Recall that a uniform tariff implies that the contract offers are observable.

industry maximizing level. Let $\left\{w^{DS}, f^{DS}\right\}$ denote the resulting equilibrium tariff, where w^{DS} is defined by $\partial \Pi_U / \partial w = 0$ and $f^{DS} = \pi\left(w^{DS}, w^{DS}\right) - \pi\left(c, w^{DS}\right)$.

Lemma 3. *Each downstream firm obtains a profit* $\pi\left(c, w^{DS}\right)$ *when both downstream firms are vertically separated.*

Downstream duopoly (entry) and vertical integration. Supplier U offers a two-part tariff that the entrant accepts. Given the unit price w, the supplier sets f such that the downstream firm's profit equals its outside option profit. The entrant's outside option profit is $\pi(c, 0)$ under vertical integration as U cannot commit to charging an input price above its marginal cost to its subsidiary I.

Supplier U now maximizes

$$\Pi_U = p_I \widetilde{q}(0, w) + w \cdot \widetilde{q}(w, 0) + \underbrace{\pi(w, 0) - \pi(c, 0)}_{\text{fixed fee of entrant}} \tag{4.4}$$

with respect to w. Let $\left\{w^{DI}, f^{DI}\right\}$ denote the resulting equilibrium tariff for the downstream duopoly in the vertically integrated case, where w^{DI} is defined by $\partial \Pi_U / \partial w = 0$ and f^{DI} equals $\pi\left(w^{DI}, 0\right) - \pi(c, 0)$.

Lemma 4. *With vertical integration of the incumbents U and I, the downstream entrant E obtains a profit of* $\pi(c, 0)$.

4.2 Entry incentives and vertical integration (stage 2)

The entrant earns a profit $\pi\left(c, w^{DS}\right)$ under separation of U and I and $\pi(c, 0)$ under integration (Lemmata 3 and 4). Recall that the profit increases as the unit input costs of the competitor increase (Assumption 2). Integration decreases the post-entry profits and thus the incentives to enter when the entrant's profit is larger under separation than integration:

$$\pi\left(c, w^{DS}\right) > \pi(c, 0).$$

This holds if U finds it optimal to set the unit input price with a downstream duopoly under separation above marginal costs:

$$w^{DS} > 0.$$

Instead, for $w^{DS} < 0$ the entrant's incentive to enter is larger under integration.

Proposition 1. *Vertical integration of U and I yields a lower post-entry profit for the entrant than separation if and only if $w^{DS} > 0$, and a higher profit iff $w^{DS} < 0$.*

We conclude that for vertical integration to affect entry, the entry costs must be in-between the profits of the entrant with vertical separation and integration of the incumbents (at least with positive probability):[16]

$$\min\left(\pi(c, 0), \pi\left(c, w^{DS}\right)\right) < \theta \leq \max\left(\pi(c, 0), \pi\left(c, w^{DS}\right)\right). \tag{4.5}$$

[16]We assume that E enters when it makes at least zero-economic profit.

Corollary 1. *Provided it is optimal for the supplier to charge a unit input price above marginal costs under vertical separation ($w^{DS} > 0$), and provided entry costs are in an intermediate range according to (4.5), then a merger between U and I decreases the entrant's post entry profit and thus the likelihood of entry.*

The above propositions make clear that it is crucial to determine whether the unit input price in the case of entry and vertical separation is above the supplier's marginal costs.

Proposition 2. *Suppose that the downstream firms compete in prices and demand satisfies Assumption 1 and 3. The unit input price under separation always exceeds U's marginal cost: $w^{DS} > 0$. Vertical integration of the established firms thus implies lower post-entry profits of the entrant than separation.*

Proof. See Appendix A. □

While the result is unambiguous with price competition, the findings are more differentiated with quantity competition. Recall that our demand assumptions are naturally fulfilled by the linear demand functions specified in equations (3.2) and (3.3).

Proposition 3. *Suppose the downstream firms compete in quantities and demand satisfies Assumption 1. The unit input price under separation exceeds U's marginal cost ($w^{DS} > 0$) if the efficiency advantage of supplier U over the alternative is sufficiently large:*

$$c \geq \hat{c} \text{ with } \hat{c} > 0. \tag{4.6}$$

For linear demand given by equation (3.2), the threshold is higher when the products are closer substitutes: $\hat{c}'(\gamma) > 0$ where $\hat{c}(\gamma)$ is defined in equation (7.6) in the appendix.

Proof. See Appendix A. □

Under price competition, vertical integration of the incumbents always leads to lower post-entry profits of the entrant than separation. With quantity competition, this is the case under condition (4.6), which implies that the unit wholesale price is above the supplier's marginal cost ($w^{DS} > 0$).

Vertical integration does not decrease the entrant's profits under quantity competition if the supplier has too strong incentives to decrease the downstream firms' outside option profits in the case of vertical separation and downstream duopoly. See equation (4.3) where c only enters the outside option profit $\pi(c, w)$. As can be seen in Figure 4.1, this incentive dominates when U's cost advantage is small, such that the downstream firms can keep a relatively large share of their flow profits. The effect is stronger when the products are less differentiated, which implies relatively intense downstream competition. A lower unit price w decreases the downstream firms' outside option profits $\pi(c, w)$. As a result, the supplier can extract a larger share of downstream profits through the fixed fees.

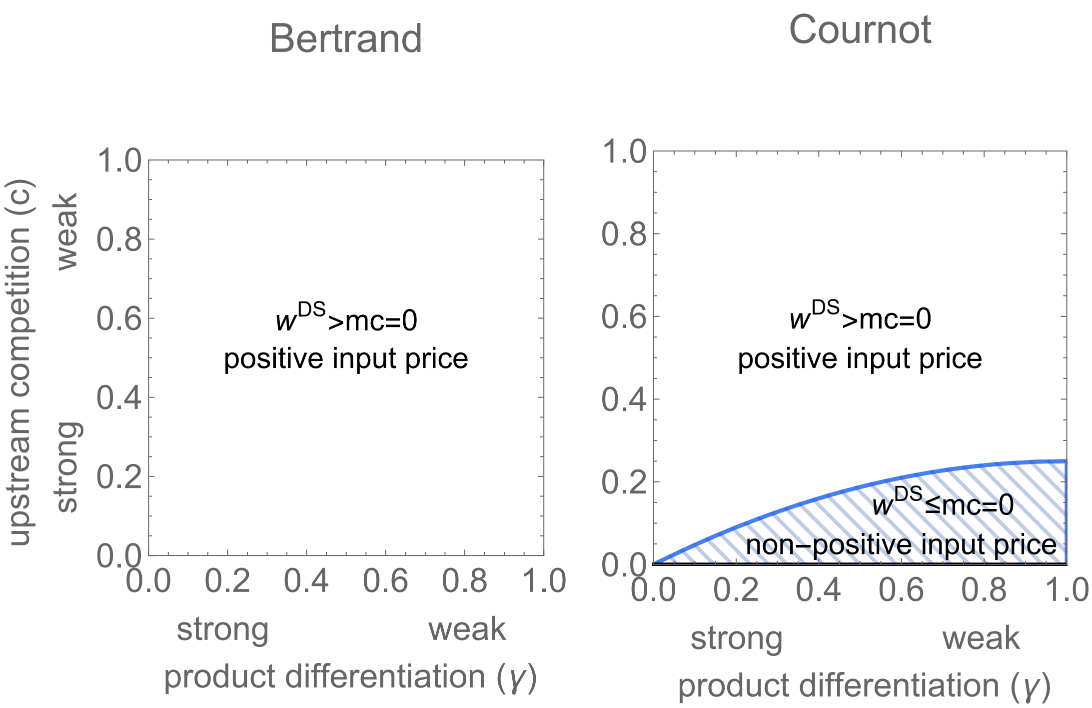

Figure 4.1: The input price w^{DS} under Bertrand (left) and Cournot (right) and separation as a function of product differentiation γ and the cost of sourcing alternatively c. A positive input price ($w^{DS} > 0$) is a price above marginal cost, whereas a negative input price ($w^{DS} < 0$) is a price below marginal cost. Note that, due to the concavity in w of U's profit function, we get $w = 0$ in case $w < 0$. This implies that the entrant's profit is independent of the imcumbent's integration decision.

Discussion: below-cost pricing. Although the (unrestricted) equilibrium unit price is below marginal cost for quantity competition if $c < \hat{c}(\gamma)$, this is not necessarily the most likely real market outcome. Unit prices below marginal cost (here $w^{DS} < 0$) can be implausible for various reasons. Prices below marginal cost may be considered anti-competitive and might be prohibited, especially when a firm has a strong or even dominant position. Intel's fidelity rebates provide an example of below marginal cost pricing of a dominant firm that was ruled to be anti-competitive by the European Commission (2009).[17] The case that vertically integrated incumbents separate in order to achieve unit wholesale pricing below marginal cost in the case of entry may thus be of little practical relevance.[18] We are therefore cautious in drawing conclusions from the case where the (unrestricted) equilibrium price is below marginal cost.

4.3 Profitability of vertical integration and welfare (stage 1)

We focus on the case where

$$\pi(c, 0) < \theta \leq \pi\left(c, w^{DS}\right), \tag{4.7}$$

which implies $w^{DS} > 0$ and thus that integration can deter entry. The condition $w^{DS} > 0$ is always fulfilled under price and under quantity competition when the fringe costs are not too

[17] Intel awarded rebates to major original equipment manufacturers under the condition that the manufacturers purchase at least 80% of their supply needs for x86 CPUs from Intel. The EU's Court of Justice ruled that Intel's behavior tied purchasers and thereby diminished the ability of competitors to compete for the respective product. The Commission furthermore ruled that Intel's use of fidelity rebates establishes an abuse of its dominant position.

[18] To determine whether such a separation would be profitable, we compare the joint profit of U and I under integration to the monopoly profit under separation. Indeed, an entry deterring separation would be profitable for vertically integrated firms if below cost pricing is possible.

large (Propositions 2 and 3). Figure 4.2 illustrates our focus on medium entry costs for the case that $w^{DS} > 0$. It also depicts that entry will always occur – irrespective of U and I's integration decision – if the entry costs satisfy $\theta < \pi(c, 0)$.[19] Instead, if $\theta > \pi\left(c, w^{DS}\right)$ the entry costs are too large such that entry is never profitable and will never occur.

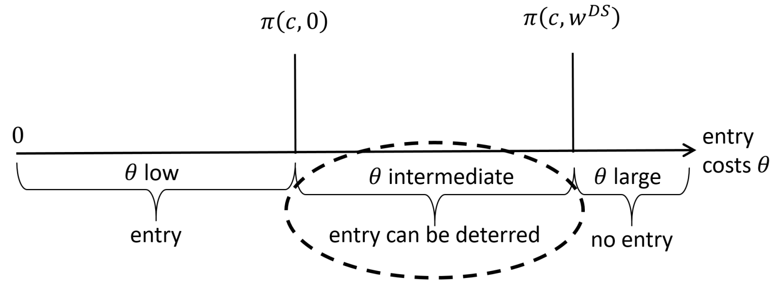

Figure 4.2: Entry always occurs for low enough entry costs and never occurs for large enough entry costs. The circle highlights our focus on intermediate entry costs and cases where $w^{DS} > 0$, which together implies that vertical integration deters entry.

Merger incentives. When the incumbents U and I are separate, market entry unleashes two countervailing effects that both enhance welfare and affect the incumbents in different ways:

- The market expands when E's product is differentiated and attracts new consumers. As U can capture some of the additional profit through the sale of its input, the *market expansion effect* makes an entry-deterring merger less profitable. The magnitude of this effect depends on the upstream margins and thus on the efficiency advantage c of the incumbent over the alternative supply source.

- Market entry creates competition in the downstream market, which leads to lower equilibrium prices and decreases profits. The *competition effect* makes an entry-deterring merger more profitable.

Proposition 4. *Suppose condition (4.7) holds, such that vertical integration of the incumbents deters entry. A vertical integration yields higher profits than separation for the incumbents if the competition effect of entry dominates its market expansion effect. With linear demand (equations (3.2) and (3.3)), this occurs when the supply alternative is efficient enough:*

$$c < \bar{c}_k(\gamma)$$

with $k \in \{Bertrand, Cournot\}$ *and* $\bar{c}_k'(\gamma) > 0$*. Equation (7.11) in the appendix defines* $\bar{c}_{Bertrand}(\gamma)$ *and equation (7.16)* $\bar{c}_{Cournot}(\gamma)$*.*

Proof. See Appendix A. □

The conditions under which entry-deterring vertical integration is profitable for the incumbents are qualitatively the same under price and quantity competition, although the exact parameter range differs slightly in the illustrative case with linear demand (see Figure 4.3):

- Vertical integration is profitable (the *competition effect* prevails) when the fringe is relatively efficient (c small) and the products are relatively homogeneous (γ large).

[19] We study this case in Appendix B.

- Vertical integration is unprofitable (the *market expansion effect* prevails) when the fringe is relatively inefficient (c large) and the products are relatively differentiated (γ small). In this case, the incumbents favor separation and E enters the market.

Figure 4.3 depicts the merger incentives of vertical integration as a function of c and γ. Entry-deterring vertical integration yields lower profits for the incumbents than vertical separation in the north-west of the dashed line and higher profits in the south-east.

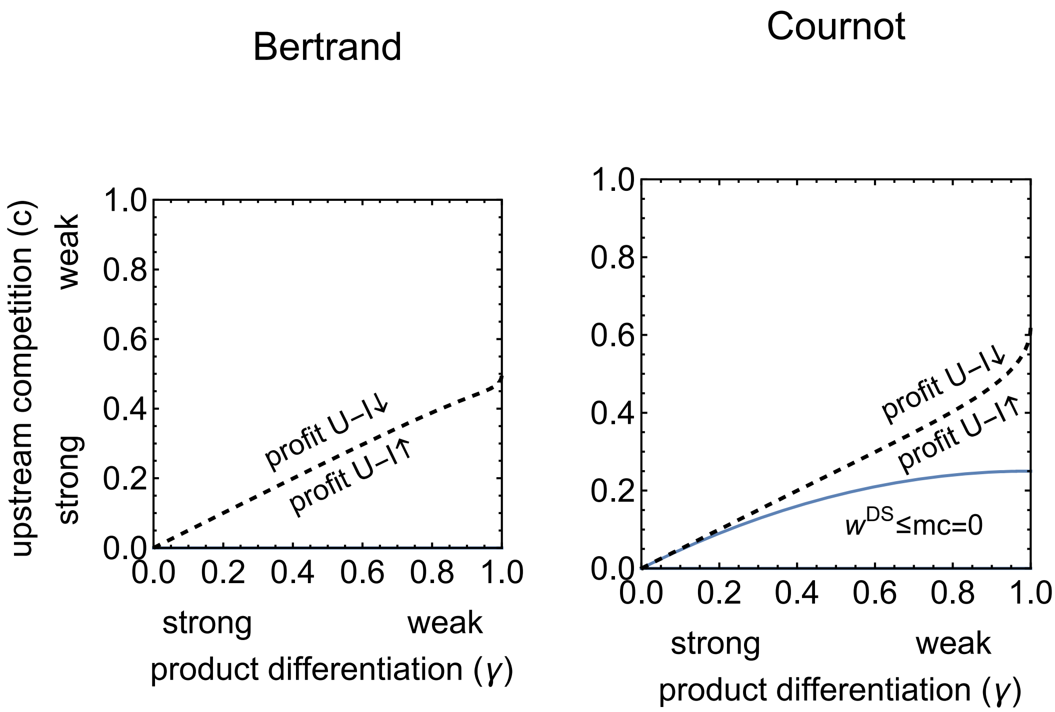

Figure 4.3: Profitability of entry-deterring vertical integration for the incumbents U and I. Vertical integration deters entry except where $w^{DS} \leq 0$ under Cournot. Entry deterring vertical integration always lowers welfare.

Welfare. For the welfare analysis we also focus on intermediate entry costs and positive unit input prices under vertical separation and duopoly (condition (4.7)).[20] To analyze the effect of vertical integration and entry deterrence on welfare, we compare welfare of the cases

- integration and downstream monopoly[21] and
- separation, entry and downstream duopoly.

Entry under vertical separation affects total welfare in three ways:

- The entry costs decrease welfare;
- The lower price level under duopoly increases welfare (competition effect);
- The additional variety under duopoly (for differentiated products) increases demand and welfare for a given price level (market expansion effect).

[20] In Appendix B, we analyze welfare, taking into account low entry costs. In doing so, we consider a duopoly in the downstream market for the welfare comparison under both integration and separation.

[21] Recall that with a downstream monopoly the market outcome and thus welfare is the same under vertical integration and vertical separation (Lemma 2).

Using the welfare function $W(q_I, q_E)$ of equation (3.4) that measures total surplus based on the linear-quadratic utility, entry under vertical separation yields higher welfare than vertical integration and no entry if

$$u\left(\widetilde{q}(w^{DS}, w^{DS}), \widetilde{q}(w^{DS}, w^{DS})\right) - \theta > u\left(\widetilde{q}(w^{M}, \infty), 0\right). \tag{4.8}$$

For the next proposition, we evaluate condition (4.8) at the upper bound of intermediate entry cost of $\bar{\theta} = \pi\left(c, w^{DS}\right)$, see inequality (4.7).

Proposition 5. *The welfare function (equation (3.4)), which is based on the linear-quadratic utility function, attains a strictly higher value under vertical separation and entry than under entry-deterring vertical integration for any value of intermediate entry costs as defined by condition (4.7).*

Proof. See Appendix A. □

For intermediate entry costs, the optimal merger policy is simple and summarized in

Corollary 2. *Whenever the unit input prices under vertical separation and duopoly are (expected to be) above costs ($w^{DS} > 0$ in the model), a vertical merger restricts potential competition with detrimental effects on welfare and thus should be prohibited absent other efficiencies (which are not modeled here).*

One may wonder whether this policy is still optimal when the entry costs are possibly not in the intermediate range. For larger entry costs, entry never occurs and vertical integration has no effects on welfare in the model. In that sense the policy does not yield a welfare loss if it is applied to cases of larger entry costs.

For entry costs that are smaller than intermediate, entry always takes place. The question is thus no more whether potential competition is restricted but whether actual competition suffers from vertical integration. We discuss this case and compare it to the case of intermediate entry costs in Appendix B.

Finally, if one expects unit input prices at the level of marginal costs ($w^{DS} = 0$), the interval of intermediate entry costs is empty (see condition (4.7)) and the analysis of either small or large entry costs applies. As the case of $w^{DS} = 0$ may only arise for certain parameter combinations (c, γ) under quantity competition (see figure 4.1), the implication for these cases apply.[22]

5 Hybrid platforms and equivalence of revenue sharing

In this section we discuss the application of our model to hybrid platforms that act both as platform operator and seller. The platform corresponds to the integrated firm where the platform operator is U and the integrated provider is I. The independent provider E can sell sell via the platform by paying the two-part tariff $\{\alpha, f\}$, where α is a revenue share. In subsection 5.1 we look at the Apple App Store case as illustrated in figure 5.1. In the App Store (U), the music streaming provider Spotify (E) competes with Apple's own music streaming app Apple Music (I). As this case includes a non-linear tariff consisting of a revenue share and a fixed fee, we formally show in subsection 5.2 that our results equally apply to cases with revenue sharing in the presence of positive marginal costs downstream.

[22] See the discussion at the end of section 4.2 for the case of unit input prices below costs.

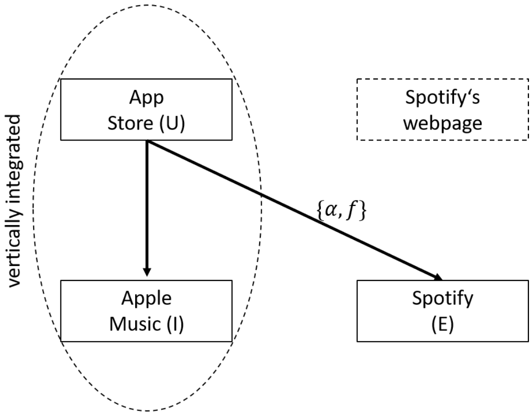

Figure 5.1: Application of our model to the example of app stores and music streaming providers.

5.1 Spotify's complaint against vertically integrated App Store

Spotify, as an independent streaming provider, pays Apple a revenue share of 30% for every in app-purchase in addition to a one-time fixed annual fee that starts from \$99.[23] Meanwhile, the integrated provider Apple Music pays no commission, which arguably gives them a cost advantage. The provision of the app and the associated services via Spotify's website in a web browser can be considered as outside options (in-house supply at cost c). Selling an app and its services through the internet has the disadvantage of a lower visibility and requires an investment in a costly payment structure.[24]

Interestingly, in March 2019, Spotify filed a complaint about high commission fees in Apple's App Store for sales of its music streaming app and in-app purchases.[25] In June 2020 the European Commission initiated an investigation into Apple's App Store rules.[26] According to the European Commission's preliminary findings, strict rules and high commission fees for in-app purchases in the App Store disadvantage music streaming apps like Spotify and detrimentally impact consumer welfare.[27] The Commission furthermore states that the App Store is a gatekeeper, that is a "closed ecosystem" for iPhone and iPad users.[28] Since 16 June 2020, the Commission investigates the App Store rules in-depth.[29]

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[23] The fees depend on the type of subscriber. In November 2020 Apple reduced the revenue share for small business with yearly earnings up to \$1 million from 30% to 15%. See "Apple announces App Store Small Business Program". Information about Apple's annual fees can be found here: "Developer Enrollment" (last access of both on 2021/12/05).

[24] See the article by Stölzel and Wettach in WirtschaftsWoche from 2020/06/17 on "Die unheimliche Macht der App-Stores" (last access 2021/08/16). According to the article, an own payment structure costs a 6 to 7 digit amount and the use of third party payment structures costs high commissions of around 50%.

[25] An e- and audiobook distributor, which competes with Apple's Apple Books app, filed a complaint against the App Store terms in March 2020. The concerns raised are similar to those of Spotify. See the press release from the European Commission on 16 June 2020 with the heading "Commission opens investigations into Apple's App Store rules" (last access 2021/08/16).

[26] See footnote 25 for a reference.

[27] For a long time, Apple was able to use its App Store rules to prohibit app providers from rerouting their customers past the App Store for paid transactions. In a lawsuit – similar to Spotify's complaint – brought by Epic Games a federal US judge ruled in September 2021 that app providers can now steer their customers past the app store for paid transactions. See the article by Albergotti from 2021/09/10 on "Judge's ruling may take a bite out of Apple's App Store, but falls short of calling the iPhone maker a monopolist" (last access 2021/10/31).

[28] The App Store rules prohibit app developers to circumvent commission fees by informing customers about out-of app purchase options (see footnote 29 for a reference).

[29] See the press release from the European Commission on 2021/04/30 with the heading "Antitrust: Commission sends Statement of Objections to Apple on App Store rules for music streaming providers" (last access 2021/08/16).

The policy case can thus be related to the model's scenario where E enters and remains in the market despite the fact that the incumbent firms U and I are integrated. Our model explains that Spotify (the entrant) may obtain lower profits when competing against the hybrid platform (Apple Music) compared to the case in which it would compete against a separated firm (e.g., Deezer). Although a detailed case analysis is out of the scope of this article, our model may rationalize the concern that vertical integration in this case is anticompetitive.

Further examples for hybrid platforms with similar payment schemes are Android's Play Store where app developers pay a commission of 30% and a one time fee of \$25[30] and Amazon where professional marketplace sellers pay a commission between 8 and 20% and a monthly fee of \$39.99.[31]

5.2 Two-part tariff with revenue share

In this section, we consider a two part tariff $\{\alpha, f\}$ which consists of a revenue share α (instead of the per unit price w) and a fixed fee f. As explained above, revenue shares are often used on online platforms, such as app stores and marketplaces, for which our model could be relevant (section 5.1).

As we will show below, revenue shares affect final prices under

Assumption 4. *The downstream firms incur a positive marginal production cost $\kappa > 0$.*

For the App Store example it seems reasonable to assume positive marginal costs at the music streaming app level as streaming services pay between 0.5 to 1 cent per stream to artists.[32] Assumption 4 is hence fulfilled.

In the case of price competition, a separated seller maximizes

$$(p_i \cdot (1-\alpha) - \kappa) \cdot q_i (p_i, p_{-i}) - f,$$

which can be rewritten as

$$(1-\alpha) \cdot \left(p_i - \frac{\kappa}{1-\alpha}\right) \cdot q_i (p_i, p_{-i}) - f.$$

The corresponding first order condition with respect to p_i is

$$q_i (p_i, p_{-i}) + \left(p_i - \frac{\kappa}{1-\alpha}\right) \cdot \frac{\partial q_i (p_i, p_{-i})}{\partial p_i} = 0,$$

which makes it easy to see that the revenue share leads to effective total marginal costs of $\kappa/(1-\alpha)$. Instead, when seller i purchases input at a per unit price w and has marginal costs κ, the total marginal costs amount to $w + \kappa$. Note that any level of marginal costs $w + \kappa$ can be achieved by appropriately choosing α in the case of revenue shares:

$$\begin{aligned} & w + \kappa = \kappa/(1-\alpha) \\ & \implies \alpha = 1 - \kappa/(w+\kappa) = \frac{w}{w+\kappa}. \end{aligned} \tag{5.1}$$

[30]The website androidauthority.com provides information about the payment structure in the Play Store: "Publishing your first app in the Play Store: what you need to know" (last access 2021/08/16).

[31]Information about the seller fees on Amazon can be found on theverge.com: "A guide to platform fees" (last access 2021/08/16).

[32]See, e.g., the article by Steele in the Wall Street Journal from 16 April 2021 with the heading "Apple music reveals how much it pays when you stream a song: Streaming services open up about artist payouts, seeking to win credibility and subscribers", (last access 2021/08/16).

Analogously to $\pi(w+\kappa, w+\kappa)$ and $\pi(c+\kappa, w+\kappa)$, we define $\pi(\kappa/(1-\alpha), \kappa/(1-\alpha))$ and $\pi(c+\kappa, \kappa/(1-\alpha))$. The participation constraint of a downstream firm thus yields

$$f = \pi(\kappa/(1-\alpha), \kappa/(1-\alpha)) - \pi(c+\kappa, \kappa/(1-\alpha)).$$

In addition, analogously to the price $\widetilde{p}(w+\kappa, w+\kappa)$ and quantity $\widetilde{q}(w+\kappa,\ w+\kappa)$, we define $\widetilde{p}(\kappa/(1-\alpha), \kappa/(1-\alpha))$ and $\widetilde{q}(\kappa/(1-\alpha), \kappa/(1-\alpha))$. The (symmetric) problem of U is thus to

$$\max_{\alpha,f} \Pi_U = \sum_{i\in\{I,E\}} \left(\alpha \cdot \widetilde{p}(\kappa/(1-\alpha), \kappa/(1-\alpha)) \cdot \widetilde{q}(\kappa/(1-\alpha), \kappa/(1-\alpha)) + f\right). \tag{5.2}$$

Substituting for f yields the objective function

$$2\left(\underbrace{(\widetilde{p}(\kappa/(1-\alpha), \kappa/(1-\alpha)) - \kappa) \cdot \widetilde{q}(\kappa/(1-\alpha), \kappa/(1-\alpha))}_{\text{industry profit}} - \underbrace{\pi(c, \kappa/(1-\alpha))}_{\text{outside option profit}}\right), \tag{5.3}$$

which U maximizes with respect to the revenue share α. Equation (5.3) shows that supplier U obtains the total industry profit except for the downstream firms' outside option profits. For comparison, the analogous maximization problem of U with a two-part tariff including a linear price w and when accounting for κ is to maximize

$$\sum_{i\in\{I,E\}} \left(\underbrace{(\widetilde{p}(w+\kappa, w+\kappa) - \kappa) \cdot \widetilde{q}(w+\kappa, w+\kappa)}_{\text{industry profit}} - \underbrace{\pi(c, w+\kappa)}_{\text{outside option profit}}\right) \tag{5.4}$$

with respect to w. From equation (5.1) we infer that there is a one to one mapping from $w+\kappa$ to $\kappa/(1-\alpha)$ implies that the latter problem is equivalent to the problem in (5.4).

Lemma 5. *Provided that i) U offers an observable two-part tariff with a fixed fee f and a revenue share α and that ii) the downstream firms incur marginal production costs ($\kappa > 0$), the same downstream prices, quantities and profits result as with a two-part tariff consisting of a marginal input price w (instead of the revenue share).*

Importantly, the lemma implies that whenever $w > 0$ in the case of two-part tariffs with a per unit price, $\alpha > 0$ results in the case of two-part tariffs with a revenue share, and analogously implies lower profits of the entrant in the case of vertical integration. This leads to the same implications for the potential of vertical integration to deter entry.

6 Additional analyses

6.1 Secret contracting

For the case of vertical separation and downstream competition, the analyses in sections 4 and 5 rely – on the assumption of uniform and thus observable contract offers. Secret and firm specific contract offers can lead to an opportunism problem as described by Hart and Tirole (1990). Let us now allow for firm-specific contract terms $\{f_i, w_i\}$, with $i \in \{I, E\}$. We will look into the following two cases where the competitors have limited information about the rival's supply source and contract terms:

- **Interim unobservability.** The non-integrated downstream firms do not know the contract that U offers to the rival. Moreover, when setting prices or quantities, the separated downstream firms do not know whether the rival accepts $U's$ offer or sources alternatively.
- **Interim observability**. The contract terms of U remain secret but the acceptance/rejection decisions of stage 4 (see section 3) and thus the decision where to source are observable when the downstream firms set their prices/quantities.

We start from the case of interim unobservability and quantity competition as analyzed in Rey and Tirole (2007) and contribute by explaining how the results differ with price competition under interim unobservability as well as under both price and quantity competition under interim observability. The analysis by Rey and Tirole (2007) of the independent downstream firms is analogous to our analysis of the entrant in terms of post-entry profits.

Interim unobservability. With *vertical separation*, the downstream firms cannot observe their rival's actual supply choice and base their strategy on the belief that their rival purchases input from the efficient supplier – which indeed happens in equilibrium. In line with Rey and Tirole (2007), we focus on equilibria with passive beliefs where, in the case of an unexpected offer, independent downstream firms believe that the competitor receives the equilibrium contract offer. The resulting symmetric equilibrium, when it exists, features unit cost pricing ($w_I = w_E = w = 0$). For the case of price competition, the equilibrium in passive beliefs only exists if the degree of product differentiation is high enough. See Rey and Tirole (2007) for the case of quantity competition and Rey and Vergé (2004) for details on the case of price competition. The reason for marginal wholesale prices equal to marginal costs is the well known opportunism problem. The upstream supplier, when making a contract offer to one downstream firm, offers a bilaterally optimal best response to the other contract (Hart and Tirole, 1990). The downstream firms' alternative supply source does not affect the marginal prices due to contract unobservability but reduces the fixed fees.

What matters for the entrant's profits is whether the downstream incumbent reacts when the entrant rejects the contract offer of U and procures the input alternatively at the higher unit input cost of c instead of $w = 0$. With interim unobservability, this is not possible as the incumbent is not aware of this deviation. With **quantity competition**, the entrant's equilibrium profit under vertical separation equals the alternative sourcing profit

$$\max_q \left(p_E \left(q, \widetilde{q}(0,0)\right) - c\right) \cdot q, \tag{6.1}$$

where E correctly anticipates the equilibrium Cournot output $\widetilde{q}(0,0)$ of the incumbent who does not react to E's deviation.

With *vertical integration* the crucial difference to separation is that contracts (i.e., the actual input costs) effectively become observable, such that the downstream firms can base their quantity and price decision on the true input cost: It is public knowledge that the integrated firm I has the true input costs of 0 and, as its subsidiary, I knows the tariffs that U charges to E. Again, what matters for the entrant's equilibrium profit is its alternative sourcing profit, which determines the equilibrium contract terms and, in particular, the fixed fee.

The entrant, when deviating, knows that the integrated downstream incumbent is aware of its deviation. The downstream incumbent thus plays a best response to the entrant's actual unit input costs of c. Given strategic substitutes under quantity competition, for the incumbent this implies a higher quantity and for the entrant a lower quantity, and thus a lower alternative sourcing profit, when compared to the case of vertical separation described above. As U sets the entrant indifferent to its alternative sourcing profit by means of the fixed fee, with quantity competition, vertical integration yields lower profits of $\pi(c, 0)$ for the entrant than the profit in equation (6.1) under vertical separation. See Rey and Tirole (2007) on p. 33 for a more detailed analysis of the case of quantity competition.

Price competition with interim unobservability is not studied by Rey and Tirole (2007) but, interestingly, yields the opposite and intriguing result: The alternative sourcing profit of the entrant now turns out to be higher under vertical integration compared to vertical separation. Vertical integration would, thus, facilitate entry. The reason is that, with price competition, each downstream firm benefits from an increase in the other firm's price due to strategic complementarity of the prices. To understand why, note that the equilibrium prices under *vertical separation* equal $\widetilde{p}(0,0)$ as $w = 0$. The entrant's equilibrium profit under vertical separation equals the alternative sourcing profit

$$\max_p \,(p - c)\, q_E(p, \widetilde{p}(0,0)), \tag{6.2}$$

where E correctly anticipates the price that firm I sets, that is $\widetilde{p}(0,0)$, while I does not observe when E deviates and therefore does not react to a deviation.

With *vertical integration*, instead, the entrant's profit when sourcing alternatively equals $\pi(c, 0)$ as in the case of observable tariffs. This is because the vertically integrated entity of U and I has complete information about the entrant's costs and will therefore charge a price $\widetilde{p}(0, c)$, which exceeds $\widetilde{p}(0,0)$. As prices are strategic complements, the entrant benefits from vertical integration: In the case of alternative sourcing, the rival's price under vertical integration is above that under vertical separation: $\widetilde{p}(0, c) > \widetilde{p}(0,0)$. This follows under standard assumptions on the profits and strategic complementarity ($\partial^2\Pi_I/(\partial p_I \partial p_E) > 0$), as it is the case with linear demand.

Proposition 6. *Under interim unobservability, the entrant's equilibrium profit is lower under vertical separation with downstream quantity competition but higher with downstream price competition.*

Interim observability. Recall that, with interim observability, the contract terms, in particular the unit wholesale price, remain secret post contract acceptance to independent downstream firms. Relative to interim unobservability, with interim observability there is thus no additional information at the stage of contract acceptance on the equilibrium path where both independent downstream firms accept $U's$ offers.

As with interim unobservability, there exists an equilibrium in passive beliefs under vertical separation where U charges each downstream firm a unit price of $w = 0$, both with price and quantity competition. See Caprice (2006) for a formal proof in the case of quantity competition.[33] The proof is analogous for price competition with the caveat that equilibrium existence is subject

[33] Proposition 1 therein; Caprice (2006) focuses on quantity competition and uses the assumption of interim observability to study a ban on price discrimination. He does not consider vertical integration.

to conditions as under full secrecy, as explained above.[34]

A difference to the case of interim unobservability arises when a downstream firm sources alternatively. The input cost of the fringe are public knowledge and, as contract acceptance is observable, the firms can adapt their sales decision when a rival sources alternatively. Suppose that, under *vertical separation*, the entrant sources alternatively. The incumbent knows that the entrant's sourcing costs are c while the entrant correctly anticipates that the incumbent's sourcing costs equals $w^{DS} = 0$. The resulting profit of the entrant thus equals $\pi(c, 0)$. This holds for both quantity and price competition.

Let us now consider the case of *vertical integration* of the incumbents when the entrant is active. On the equilibrium path, U will serve the entrant. The analysis of this case is equivalent to the case of interim unobservability described above. What matters for the entrant's equilibrium profit is again its alternative sourcing profit. The downstream incumbent knows the true costs of the entrant in the case of a deviation. This yields again a profit for the entrant of $\pi(c, 0)$.

Proposition 7. *Under interim observability, the entrant's equilibrium profit is the same under vertical separation and vertical integration of the incumbents, both with downstream quantity and price competition. It equals the profits $\pi(c, 0)$ under full observability and integration as defined in section 3.*

Discussion of results. Table 1 compares the entrant's profits with interim (un-) observable contract offers to our main results with observable contract offers. Recall that for the analysis with observable offers we focus on the case that marginal wholesale prices below marginal costs are not feasible.[35]

In the case of interim unobservability, vertical integration hurts the entrant with strategic substitutes (competition in quantities) as it provides the integrated downstream rival with knowledge about the entrant's deviation to higher marginal costs, which leads to a more aggressive action of the rival. This result is due to Rey and Tirole (2007). Focusing on equilibria with passive beliefs, we have illustrated that with strategic complementarity (price competition) the opposite happens: The integrated downstream rival's knowledge about the alternative sourcing leads to the accommodating action of a higher price, which benefits the entrant. Moreover, vertical integration does not affect the entrant's profits when the decisions where to source become observable (interim observability).

The reasons for the different profits of the entrant under vertical integration and vertical separation differ between observable and interim unobservable contract offers. When the contracts are secret, the opportunism problem prevents the efficient upstream firm under vertical separation from charging unit prices above its marginal cost. Vertical integration informs the incumbent about alternative sourcing of the rival and leads to an optimal reaction on the sales market (less aggressive pricing or more aggressive quantity choice).

[34] Moreover, marginal cost pricing may no longer exist in the case of wary beliefs, see Rey and Vergé (2004).

[35] This matters for the case of quantity competition where, for certain competition parameters, wholesale prices below cost would otherwise result.

	competition in	
	prices	**quantities**
(i) contract offers interim unobservable	$\max_p (p-c)\, q_E\left(p, \widetilde{p}(0,0)\right)$ $< \pi(c,0)$ *	$\max_q \left(p_E\left(q, \widetilde{q}(0,0)\right) - c\right)\cdot q$ $> \pi(c,0)$
(ii) .. interim observable	$\pi(c,0) = \pi(c,0)$	$\pi(c,0) = \pi(c,0)$
(iii) .. observable	$\pi\left(c, w^{DS}\right) > \pi(c,0)$ with $w^{DS} > 0$	$\pi\left(c, w^{DS}\right) <> \pi(c,0)$ as $w^{DS} <> 0$ **

Table 1: Comparison of entrant's profits between separation (left) and vertical integration of the incumbents for different scenarios of contract observability.
*See the remarks on equilibrium existence in the above paragraph on interim unobservability.
**The case $\pi(c, w^{DS}) > \pi(c,0)$ occurs for a large range of parameters with linear demand. The case $\pi(c, w^{DS}) < \pi(c,0)$ only occurs if negative marginal input prices are feasible. See Proposition 3.

Prices above marginal costs, and thereby strategic double marginalization, instead occur when the contracts are observable. Vertical integration eliminates the double marginalization of the incumbents and yields more aggressive downstream competition when the entrant sources alternatively. This holds for price competition and a large parameter range of quantity competition (Propositions 2 and 3).

6.2 Exclusive dealing

Our main analysis works under the premise that exclusive dealing is not feasible as U cannot credibly commit not to serve E should entry occur. In other words, exclusive dealing is not part of a subgame-perfect equilibrium.

This section analyses the case in which U can credibly commit to exclusively serve I. Formally speaking, we consider vertical separation and replace stage one of the game in section 3 by the option for U to publicly commit to not supply E in the case of entry. We discuss whether the incumbents U and I have the ability and incentive to deter entry by means of exclusive dealing. To determine the exclusive dealing incentives of U and I, we study their joint profits and (implicitly) assume that a monetary transfer between I to U is possible in stage 1 as part of the exclusive dealing commitment.

Whether exclusive dealing reduces the entry incentives is not obvious as E can always source form the fringe, provided it is efficient enough. Moreover, without exclusive dealing, E only obtains a profit equal to its outside option profit when sourcing from U.

In the case of entry and with exclusive dealing (denoted in equilibrium by ED), I's participation constraint is:

$$\pi\left(w^{ED}, c\right) - f \geq \pi(c,c).$$

In equilibrium this constraint binds and yields

$$f = \pi\left(w^{ED}, c\right) - \pi(c, c).$$

Supplier U's problem thus is to

$$\max_w \Pi_U = w \cdot q_I + \underbrace{\pi(w, c) - \pi(c, c)}_{\text{fixed fee}}.$$

The supplier effectively maximizes the full profit of products sold by I when setting w. Under the assumption that the contract is observable to the entrant and that the input prices are unrestricted, the equilibrium price w^{ED} will generally differ from the marginal costs due to strategic delegation (Bonanno and Vickers, 1988).[36] However, with exclusive dealing there is no more the incentive to lower the wholesale price in order to decrease the value of the other's downstream firms outside option profit (as in equation (4.3)).

Exclusive dealing decreases the entrant's profit ($\pi^{ED}\left(c, w^{ED}\right) < \pi^{DS}\left(c, w^{DS}\right)$) if the input price of the incumbent under exclusive dealing is below that without exclusivity: $w^{ED} < w^{DS}$. Moreover, exclusive dealing is as deterrent as vertical integration when $w^{ED} = 0$.

Lemma 6. *Under price competition and with linear demand, exclusive dealing has a deterrent effect relative to vertical separation ($w^{ED} < w^{DS}$) for a large parameter range when the fringe is not too efficient (condition (7.20) holds). Otherwise, U sets $w^{ED} = w^{DS} = c$ and the entry incentives are equal under separation and exclusive dealing. Exclusive dealing is always less deterrent than vertical integration ($w^{ED} > 0$).*

Proof. See Appendix A. □

Lemma 7. *Under quantity competition and with linear demand, exclusive dealing has a deterrent effect relative to vertical separation ($w^{ED} < w^{DS}$) for all $c > \hat{c}$ as defined in Proposition 3. Under the restriction that the marginal wholesale price must not be below marginal costs, exclusive dealing has the same effect as vertical integration: U sells input to I at marginal costs under exclusive dealing ($w^{ED} = 0$), such that the outside option profit becomes $\pi(c, 0)$.*[37]

Proof. See Appendix A. □

Note that entry deterring exclusive dealing is always profitable when vertical integration is profitable. We assume that vertical integration as well as exclusive dealing decrease the entrant's profit by so much that entry does not occur. In consequence, for both entry deterring instruments, we compare the joint monopoly profit of U and I to the joint profit under separation to establish integration or exclusive dealing incentives.

Corollary 3. *As with vertical integration, exclusive dealing is profitable (the competition effect prevails) when the fringe is relatively efficient (c small) and the products are relatively homogeneous (γ large). Vertical integration is unprofitable (the market expansion effect prevails) when the fringe is relatively inefficient (c large) and the products are relatively differentiated (γ small). In this case, the incumbents favor separation and E enters the market.*

[36] If one assumes that the exclusive contract becomes interim unobservable, the outcome would resemble that of vertical integration with wholesale prices equal to costs. A wholesale price above costs for the integrated downstream firm entails no commitment for the rival. It is thus optimal for the integrated entity that its downstream firm plays a best response based on the true input costs.

[37] When prices are unrestrained, U set prices below its marginal costs.

In summary, exclusive dealing has a deterrent effect relative to vertical separation in most cases, except for price competition and intensive up- and downstream competition. Under quantity competition, exclusive dealing is similarly effective as vertical integration but less effective under price competition. It can therefore serve as (an imperfect) substitute to vertical integration.

In addition, exclusive dealing has the drawback that U cannot benefit from the market expansion effect that arises in case E enters the market despite the exclusive contract (e.g., because it has lower entry costs than expected). This would decrease productive efficiency as well. We conclude that exclusive dealing is a less effective instrument compared to vertical integration to deter entry.

7 Conclusion

We review the Chicago School's *single monopoly profit* theory whereby an upstream monopolist, which can use contracts to extract all monopoly profits from the downstream firms, cannot generate additional profits through vertical integration. For this, we employ a model where the upstream firm uses observable two-part tariffs to sell inputs to a downstream incumbent and – in the case of entry – an entrant.

For the case that the downstream firms cannot avoid sourcing from the upstream firm in order to be active in the market, our results are consistent with the Chicago School's *single monopoly profit* theory. The upstream monopolist, which can use contracts to extract all monopoly profits from downstream firms, cannot generate additional profits through vertical integration. The downstream entrant's profit equals its outside option irrespective of vertical integration, such that the vertical integration of the incumbents has no effect on the incentives to enter the market.

The result is different when the downstream firms can alternatively produce the inputs less efficiently in-house or purchase them from a competitive fringe supply. With an alternative input supply, the outside option value of the downstream entrant does depend on whether there is a vertical integration of the established up- and downstream firms.

We show by means of reduced-form as well as linear demand that, with the vertical integration, an independent entrant faces a more aggressive competitor when obtaining the inputs alternatively (the outside option) and thus makes lower profits when the dominant supplier sells input above its marginal costs. This result holds with downstream price competition under relatively general demand assumptions, including the case of linear demand. It also holds for quantity competition, provided that the alternative fringe supply is not too efficient. For reference, we show that vertical integration can be more effective in deterring entry than an exclusive dealing between the up- and downstream incumbents.

If the entry costs are in an intermediate range where a vertical merger can deter entry, the following trade-off arises for the incumbent firms: On the one hand, vertical integration would deter entry and retain the downstream monopoly. On the other hand, with vertical separation, entry occurs and the upstream incumbent can capture a share of the additional profits generated through entry and market expansion. We show that the incumbents only merge if the loss of profits due to competition that results from entry exceeds the additional profits generated through market expansion.

Our parametric computations with the linear demand function reveal that entry deterrence through vertical integration is always to the detriment of welfare in the case of observable two-part tariffs. Our model suggests the following optimal merger policy for the setting when entry is possible and the upstream firm faces no opportunism problem as in Hart and Tirole (1990): Absent further efficiencies, a vertical merger should be prohibited based on the theory of harm that potential competition is restricted.

This finding is complementary to the case that entry has already taken place. For this case, a merger assessment needs to take the effects on actual instead of potential competition into account. Sandonís and Faulí-Oller (2006) have shown for this case that vertical integration reduces welfare only when the alternative supply is relatively efficient.[38]

Our results are also complementary to the findings of Rey and Tirole (2007) whereby vertical integration can reduce an independent downstream firm's profit in the case of secret contracting with a competitive fringe supply. We show that the finding crucially depends on the assumptions of quantity competition and full secrecy and illustrate that opposite implications may arise either under price competition or interim observability of the sourcing decisions. This emphasizes that the nature of the supply contracts between up- and downstream firms as well as the type of competition (price versus quantity) can matter for the competitive effects of vertical mergers. Overall, the case where the dominant supplier does not face an opportunism problem, and thus has (more) market power, arguably better reflects settings that the Chicago School's *single monopoly profit* theory has in mind.

The main take-away of this article is that vertical integration can also restrict potential competition in settings where an educated observer, who is aware of the previous economic literature on foreclosure, may think that there is a monopoly-like situation where the classic Chicago School's *single monopoly profit* theory could apply and vertical integration would not raise competitive concerns. Our analysis highlights that an in-depth review of the likely effects of a proposed vertical merger on potential competition needs to incorporate a careful analysis that takes competitive constraints at the upstream level correctly into account. To draw reliable policy conclusions based on the complex theories of vertical relations, one needs to obtain insights on the type of wholesale tariffs and the contracting process, along with an understanding of the type and intensity of competition.

Our model extends to revenue-sharing tariffs and can be related to the case of Spotify who filed a complaint in March 2019 regarding preferencing of Apple's integrated Apple Music App in the App Store. While a full-fledged analysis is out of the scope of this article, our model could rationalize that Spotify (the entrant) obtains lower profits when competing against the hybrid platform (Apple Music) compared to the case in which it would compete against a separated firm (e.g., Deezer). This may support the concern that vertical integration in this case is anticompetitive.

[38]We relate to their analysis in Appendix B.

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Appendix A: Proofs

Proof of Proposition 2. Equation (4.3) can be rewritten as the industry profit less the downstream firms outside options:

$$\Pi_U = 2 \cdot \left[\widetilde{p}(w,w) \cdot q_i\left(\widetilde{p}(w,w), \widetilde{p}(w,w)\right) - \left[\left(\widetilde{p}(c,w) - c\right) \cdot q_i\left(\widetilde{p}(c,w), \widetilde{p}(w,c)\right)\right]\right]. \tag{7.1}$$

Differentiating equation (7.1) with respect to the per unit price w and dividing by the number of separate downstream firms yields

$$\begin{aligned} \frac{\partial \Pi_U}{\partial w} \cdot \frac{1}{2} = & \left(\frac{\partial \widetilde{p}(w,w)}{\partial w_i} + \frac{\partial \widetilde{p}(w,w)}{\partial w_{-i}}\right) \cdot q_i\left(\widetilde{p}(w,w), \widetilde{p}(w,w)\right) \\ & + \widetilde{p}(w,w)\left(\frac{\partial q_i}{\partial p_i} + \frac{\partial q_i}{\partial p_{-i}}\right) \cdot \left(\frac{\partial \widetilde{p}(w,w)}{\partial w_i} + \frac{\partial \widetilde{p}(w,w)}{\partial w_{-i}}\right) - \left[\frac{\partial \widetilde{p}(c,w)}{\partial w_{-i}} \cdot q_i\left(\widetilde{p}(c,w), \widetilde{p}(w,c)\right)\right. \\ & \left. + \left(\widetilde{p}(c,w) - c\right) \cdot \left(\frac{\partial q_i\left(\widetilde{p}(c,w), \widetilde{p}(w,c)\right)}{\partial p_i} \frac{\partial \widetilde{p}(c,w)}{\partial w_{-i}} + \frac{\partial q_i\left(\widetilde{p}(c,w), \widetilde{p}(w,c)\right)}{\partial p_{-i}} \frac{\partial \widetilde{p}(w,c)}{\partial w_i}\right)\right], \end{aligned} \tag{7.2}$$

where the index i (and $-i$) denotes the derivative with respect to the first (second) argument of the price function.

Now set $w = 0$ in order to assess the marginal incentive to change w at the point $w = 0$; $\frac{\partial \Pi_U}{\partial w} \cdot \frac{1}{2}$ becomes

$$\begin{aligned} & \left(\frac{\partial \widetilde{p}(0,0)}{\partial w_i} + \frac{\partial \widetilde{p}(0,0)}{\partial w_{-i}}\right) \cdot q_i\left(\widetilde{p}(0,0), \widetilde{p}(0,0)\right) \\ & + \widetilde{p}(0,0)\left(\frac{\partial q_i}{\partial p_i} + \frac{\partial q_i}{\partial p_{-i}}\right) \cdot \frac{\partial \widetilde{p}(0,0)}{\partial w_i} + \frac{\partial \widetilde{p}(0,0)}{\partial w_{-i}} - \left[\frac{\partial \widetilde{p}(c,0)}{\partial w_{-i}} \cdot q_i\left(\widetilde{p}(c,0), \widetilde{p}(0,c)\right)\right. \\ & \left. + \left(\widetilde{p}(c,0) - c\right) \cdot \left(\frac{\partial q_i\left(\widetilde{p}(c,0), \widetilde{p}(0,c)\right)}{\partial p_i} \frac{\partial \widetilde{p}(c,0)}{\partial w_{-i}} + \frac{\partial q_i\left(\widetilde{p}(c,0), \widetilde{p}(0,c)\right)}{\partial p_{-i}} \frac{\partial \widetilde{p}(0,c)}{\partial w_i}\right)\right]. \end{aligned}$$

Simplifying the above yields $\frac{\partial \Pi_U}{\partial w} \cdot \frac{1}{2} =$

$$\begin{aligned} & \left(\frac{\partial \widetilde{p}(0,0)}{\partial w_i} + \frac{\partial \widetilde{p}(0,0)}{\partial w_{-i}}\right) \cdot \left[q_i\left(\widetilde{p}(0,0), \widetilde{p}(0,0)\right) + \widetilde{p}(0,0)\left(\frac{\partial q_i}{\partial p_i} + \frac{\partial q_i}{\partial p_{-i}}\right)\right] \\ & - \left[\frac{\partial \widetilde{p}(c,0)}{\partial w_{-i}} \cdot q_i\left(\widetilde{p}(c,0), \widetilde{p}(0,c)\right) + \left(\widetilde{p}(c,0) - c\right) \cdot \left(\frac{\partial q_i}{\partial p_i} \frac{\partial \widetilde{p}(c,0)}{\partial w_{-i}} + \frac{\partial q_i}{\partial p_{-i}} \frac{\partial \widetilde{p}(0,c)}{\partial w_i}\right)\right]. \end{aligned} \tag{7.3}$$

The first order condition (foc) of a downstream firm's profit function for $w = 0$ when both firms buy from U for an input price of w is

$$q_i\left(\widetilde{p}(0,0), \widetilde{p}(0,0)\right) + \widetilde{p}(0,0)\left(\frac{\partial q_i\left(\widetilde{p}(0,0), \widetilde{p}(0,0)\right)}{\partial p_i}\right) = 0.$$

We plug the foc into equation (7.3) to get $\frac{\partial \Pi_U}{\partial w} \cdot \frac{1}{2}$ equal to

$$\begin{aligned} & \left(\frac{\partial \widetilde{p}(0,0)}{\partial w_i} + \frac{\partial \widetilde{p}(0,0)}{\partial w_{-i}}\right) \cdot \left[q_i\left(\widetilde{p}(0,0), \widetilde{p}(0,0)\right) + \widetilde{p}(0,0)\left(\frac{\partial q_i}{\partial p_{-i}}\right)\right] \\ & - \left[\frac{\partial \widetilde{p}(c,0)}{\partial w_{-i}} \cdot q_i\left(\widetilde{p}(c,0), \widetilde{p}(0,c)\right) + \left(\widetilde{p}(c,0) - c\right) \cdot \left(\frac{\partial q_i}{\partial p_i} \frac{\partial \widetilde{p}(c,0)}{\partial w_{-i}} + \frac{\partial q_i}{\partial p_{-i}} \frac{\partial \widetilde{p}(0,c)}{\partial w_i}\right)\right]. \end{aligned}$$

The foc of a downstream firm that purchases alternatively for an input price of c while the other downstream firm obtains input at a price of $w = 0$ is

$$q_i\left(\widetilde{p}(c,0), \widetilde{p}(0,c)\right) + \left(\widetilde{p}(c,0) - c\right) \frac{\partial q_i}{\partial p_i} = 0.$$

We use the foc to get

$$\frac{\partial \Pi_U}{\partial w}\cdot\frac{1}{2}=\underbrace{\left(\frac{\partial \widetilde{p}\,(0,0)}{\partial w_i}+\frac{\partial \widetilde{p}\,(0,0)}{\partial w_{-i}}\right)\cdot\left[q_i\left(\widetilde{p}\,(0,0)\,,\widetilde{p}\,(0,0)\right)+\widetilde{p}\,(0,0)\,\frac{\partial q_i}{\partial p_{-i}}\right]}_{>0}$$
$$-\underbrace{(\widetilde{p}\,(c,0)-c)\cdot\left(\frac{\partial q_i}{\partial p_{-i}}\frac{\partial \widetilde{p}\,(0,c)}{\partial w_i}\right)}_{>0}.$$

To asses the marginal effect of the derivative $\partial\Pi_U/\partial w$ we set $c=0$ and get

$$\begin{aligned}\frac{\partial \Pi_U}{\partial w}\cdot\frac{1}{2}&=\left(\frac{\partial \widetilde{p}\,(0,0)}{\partial w_i}+\frac{\partial \widetilde{p}\,(0,0)}{\partial w_{-i}}\right)\cdot\left[q_i\left(\widetilde{p}\,(0,0)\,,\widetilde{p}\,(0,0)\right)+\widetilde{p}\,(0,0)\,\frac{\partial q_i}{\partial p_{-i}}\right]\\&\quad-\widetilde{p}\,(0,0)\cdot\left(\frac{\partial q_i}{\partial p_{-i}}\frac{\partial \widetilde{p}\,(0,0)}{\partial w_i}\right)\\&=\left(\frac{\partial \widetilde{p}\,(0,0)}{\partial w_i}+\frac{\partial \widetilde{p}\,(0,0)}{\partial w_{-i}}\right)\cdot q_i+\frac{\partial \widetilde{p}\,(0,0)}{\partial w_{-i}}\cdot\widetilde{p}\,(0,0)\,\frac{\partial q_i}{\partial p_{-i}}>0.\end{aligned}$$

This means that for $c=0$ and, by continuity, small values of $c>0$, the optimal wholesale price (w) is positive (concavity of the objective function).

We now implicitly differentiate equation (7.2) to evaluate $dw/dc = -\frac{\partial^2\Pi_U/\partial w\partial c}{\partial^2\Pi_U/(\partial w)^2}$.

$$\begin{aligned}\frac{\partial^2\Pi_U}{\partial w\partial c}=&\frac{\partial}{\partial w}\frac{\partial}{\partial c}\left[\underbrace{\sum_{i\in\{I,\,E\}}\left(w\cdot\widetilde{q}\,(w,w)+\pi\,(w,w)-\pi\,(c,w)\right)}_{\text{industry profit less fixed fee}}\right]\\=&\frac{\partial}{\partial w}\frac{\partial}{\partial c}\left[-\pi\,(c,w)\right].\end{aligned}$$

Note that $\pi(c,w)=(\widetilde{p}\,(c,w)-c)\cdot q_i\left(\widetilde{p}\,(c,w)\,,\widetilde{p}\,(w,c)\right)=\widetilde{\pi}\left(\widetilde{p}\,(w,c)\,,c\right)$. The envelope theorem implies that $\frac{d\widetilde{\pi}}{dc}=\frac{\partial\widetilde{\pi}}{\partial c}=-q_i\left(\widetilde{p}\,(c,w)\,,\widetilde{p}\,(w,c)\right)$.
This yields

$$\begin{aligned}\frac{\partial^2\Pi_U}{\partial w\partial c}\cdot\frac{1}{2}&=\frac{\partial}{\partial w}\frac{\partial}{\partial c}\left[-\pi\,(c,w)\right]=\frac{\partial}{\partial w}\left[q_i\left(\widetilde{p}\,(c,w)\,,\widetilde{p}\,(w,c)\right)\right]=\\&=\underbrace{\frac{\partial q_i\left(\widetilde{p}\,(c,w)\,,\widetilde{p}\,(w,c)\right)}{\partial p_i}}_{<0}\underbrace{\frac{\partial \widetilde{p}\,(c,w)}{\partial w_{-i}}}_{>0}+\underbrace{\frac{\partial q_i\left(\widetilde{p}\,(c,w)\,,\widetilde{p}\,(w,c)\right)}{\partial p_{-i}}}_{>0}\underbrace{\frac{\partial \widetilde{p}\,(w,c)}{\partial w_i}}_{>0}.\end{aligned}$$

This expression is positive under Assumption 3.
Together with strict concavity of Π_U in w, this implies that

$$dw/dc=-\frac{\partial^2\Pi_U/\partial w\partial c}{\partial^2\Pi_U/(\partial w)^2}>0.$$

Hence, the larger c, the higher is the optimal wholesale price. This means that also for larger values of c, the optimal wholesale price in the case of vertical separation and downstream duopoly is positive. □

Proof of Proposition 3. When the downstream firms compete in quantities, U's objective function is to

$$\begin{aligned} max_w \Pi =& 2\cdot \left[p_i\left(\widetilde{q}\left(w,w\right),\widetilde{q}\left(w,w\right)\right)\cdot \widetilde{q}\left(w,w\right)\right.\\ &\left.-\left[\left(p_i\left(\widetilde{q}\left(c,w\right),\widetilde{q}\left(w,c\right)\right)-c\right)\cdot \widetilde{q}\left(c,w\right)\right]\right].\end{aligned}$$

The derivative of U's profit with respect to the per unit price w is given by

$$\begin{aligned} \frac{\partial \Pi_U}{\partial w}\cdot\frac{1}{2} =& \left(\frac{\partial p_i\left(\widetilde{q}\left(w,w\right),\widetilde{q}\left(w,w\right)\right)}{\partial q_i}+\frac{\partial p_i\left(\widetilde{q}\left(w,w\right),\widetilde{q}\left(w,w\right)\right)}{\partial q_{-i}}\right)\\ &\cdot\left(\frac{\partial \widetilde{q}\left(w,w\right)}{\partial w_i}+\frac{\partial \widetilde{q}\left(w,w\right)}{\partial w_{-i}}\right)\cdot \widetilde{q}\left(w,w\right)\\ &+p_i\left(\widetilde{q}\left(w,w\right),\widetilde{q}\left(w,w\right)\right)\cdot\left(\frac{\partial \widetilde{q}\left(w,w\right)}{\partial w_i}+\frac{\partial \widetilde{q}\left(w,w\right)}{\partial w_{-i}}\right)\\ &-\left[\widetilde{q}\left(c,w\right)\cdot\left(\frac{\partial p_i\left(\widetilde{q}\left(c,w\right),\widetilde{q}\left(w,c\right)\right)}{\partial q_i}\frac{\partial \widetilde{q}\left(c,w\right)}{\partial w_{-i}}\right.\right.\\ &\left.+\frac{\partial p_i\left(\widetilde{q}\left(c,w\right),\widetilde{q}\left(w,c\right)\right)}{\partial q_{-i}}\frac{\partial \widetilde{q}\left(w,c\right)}{\partial w_i}\right)\\ &\left.+\left(p_i\left(\widetilde{q}\left(c,w\right),\widetilde{q}\left(w,c\right)\right)-c\right)\cdot\frac{\partial \widetilde{q}\left(c,w\right)}{\partial w_{-i}}\right].\end{aligned} \tag{7.4}$$

Set $w=0$ and rearrange to get $\partial\Pi_U/\partial w\cdot 1/2 =$

$$\begin{aligned} &\left[\left(\frac{\partial p_i\left(\widetilde{q}\left(0,0\right),\widetilde{q}\left(0,0\right)\right)}{\partial q_i}+\frac{\partial p_i\left(\widetilde{q}\left(0,0\right),\widetilde{q}\left(0,0\right)\right)}{\partial q_{-i}}\right)\cdot \widetilde{q}\left(0,0\right)+p_i\left(\widetilde{q}\left(0,0\right),\widetilde{q}\left(0,0\right)\right)\right]\\ &\cdot\left(\frac{\partial \widetilde{q}\left(0,0\right)}{\partial w_i}+\frac{\partial \widetilde{q}\left(0,0\right)}{\partial w_{-i}}\right)\\ &-\left[\left(\frac{\partial p_i\left(\widetilde{q}\left(c,0\right),\widetilde{q}\left(0,c\right)\right)}{\partial q_i}\frac{\partial \widetilde{q}\left(c,0\right)}{\partial w_{-i}}+\frac{\partial p_i\left(\widetilde{q}\left(c,0\right),\widetilde{q}\left(0,c\right)\right)}{\partial q_{-i}}\frac{\partial \widetilde{q}\left(0,c\right)}{\partial w_i}\right)\cdot \widetilde{q}\left(c,0\right)\right.\\ &\left.+\left(p_i\left(\widetilde{q}\left(c,0\right),\widetilde{q}\left(0,c\right)\right)-c\right)\cdot\frac{\partial \widetilde{q}\left(c,0\right)}{\partial w_{-i}}\right].\end{aligned}$$

We use the foc for a downstream firm when both firms purchase input from U at w,

$$p_i\left(\widetilde{q}\left(0,0\right),\widetilde{q}\left(0,0\right)\right)+\frac{\partial p_i\left(\widetilde{q}\left(0,0\right),\widetilde{q}\left(0,0\right)\right)}{\partial q_i}\widetilde{q}\left(0,0\right)=0,$$

and the foc in case one of the downstream firms deviates unilaterally and purchases input from the fringe,

$$\left(p_i\left(\widetilde{q}\left(c,0\right),\widetilde{q}\left(0,c\right)\right)-c\right)+\widetilde{q}\left(c,0\right)\frac{\partial p_i\left(\widetilde{q}\left(c,0\right),\widetilde{q}\left(0,c\right)\right)}{\partial q_i}=0,$$

to obtain

$$\begin{aligned} \frac{\partial \Pi_U}{\partial w}\cdot\frac{1}{2} =& \left[\frac{\partial p_i\left(\widetilde{q}\left(0,0\right),\widetilde{q}\left(0,0\right)\right)}{\partial q_{-i}}\cdot \widetilde{q}\left(0,0\right)\right]\left(\frac{\partial \widetilde{q}\left(0,0\right)}{\partial w_i}+\frac{\partial \widetilde{q}\left(0,0\right)}{\partial w_{-i}}\right)\\ &-\left[\frac{\partial p_i\left(\widetilde{q}\left(c,0\right),\widetilde{q}\left(0,c\right)\right)}{\partial q_{-i}}\frac{\partial \widetilde{q}\left(0,c\right)}{\partial w_i}\cdot \widetilde{q}\left(c,0\right)\right].\end{aligned}$$

To asses the marginal effect of the derivative, we set $c = 0$ and get

$$\frac{\partial \Pi_U}{\partial w} \cdot \frac{1}{2} = \underbrace{\frac{\partial p_i\left(\widetilde{q}\left(0,0\right), \widetilde{q}\left(0,0\right)\right)}{\partial q_{-i}}}_{<0} \cdot \widetilde{q}\left(0,0\right) \cdot \underbrace{\frac{\partial \widetilde{q}\left(0,0\right)}{\partial w_{-i}}}_{>0} < 0.$$

This means that for $c = 0$ and, by continuity, small values of $c > 0$, the optimal wholesale price (w) is negative (concavity of the objective function). We now implicitly differentiate equation (7.4) to evaluate $dw/dc = -\frac{\partial^2 \Pi_U/\partial w \partial c}{\partial^2 \Pi_U/(\partial w)^2}$. The nominator is given by

$$\begin{aligned} =&\frac{\partial}{\partial c}\frac{\partial}{\partial w}\left[\sum_{i \in \{I,E\}}\left(w \cdot \widetilde{q}\left(w,w\right) + \underbrace{\pi\left(w,w\right) - \pi\left(c,w\right)}_{\text{fixed fee}}\right)\right] \\ =&\frac{\partial}{\partial w}\frac{\partial}{\partial c}\left[-\pi\left(c,w\right)\right]. \end{aligned}$$

Note that $\pi(c,w) = \left(p_i\left(\widetilde{q}\left(c,w\right), \widetilde{q}\left(w,c\right)\right) - c\right) \cdot \widetilde{q}\left(c,w\right) = \widetilde{\pi}\left(\widetilde{q}\left(w,c\right), c\right)$. The envelope theorem implies that $\frac{d\widetilde{\pi}}{dc} = \frac{\partial \widetilde{\pi}}{\partial c} = -\widetilde{q}\left(c,w\right)$.

This yields

$$\frac{\partial^2 \Pi_U}{\partial w \partial c} \cdot \frac{1}{2} = \frac{\partial}{\partial w}\frac{\partial}{\partial c}\left[-\pi\left(c,w\right)\right] = \frac{\partial}{\partial w}\left[\widetilde{q}\left(c,w\right)\right] = \frac{\partial \widetilde{q}\left(c,w\right)}{\partial w_{-i}} > 0$$

as with strategic substitutes the own output increases in the rival's costs.

Together with strict concavity of Π_U in w, this implies that $dw/dc > 0$. By continuity, there thus exists a threshold $\hat{c} > 0$ of the fringe cost, such that for $c \geq \hat{c}$, the optimal wholesale price in the case of vertical separation and downstream duopoly is positive.

With the linear demand function specified in equation (3.2) the optimal input price is

$$w^{DS} = \frac{\gamma\left(\left(\gamma - 2\right)\gamma + 4c\right)}{2\left(\gamma^3 - 2\gamma^2 + 4\right)}, \tag{7.5}$$

which is positive for $c \geq \hat{c}$, with

$$\hat{c}(\gamma) = \frac{1}{4}\gamma\left(2 - \gamma\right), \tag{7.6}$$

which implies $\hat{c}'\left(\gamma\right) = 1/2 \cdot \left(1 - \gamma\right) > 0$ in the relevant parameter range. □

Proof of Proposition 4. To determine the merger incentives, we focus on the case in which supplier U sets an input price above marginal costs $\left(w^{DS} > 0\right)$ and in which entry costs are in an intermediate range: $\pi\left(c,0\right) < \theta < \pi\left(c, w^{DS}\right)$. We now demonstrate that, given linear demand as defined in equations (3.2) and (3.3), the incumbents can profitably integrate when the supply alternative is relatively efficient.

First, calculate the joint equilibrium profit of supplier U and downstream firm I for (i) the monopoly case, denoted Π^M (here it does not matter whether firms are integrated or separated) and (ii) the separated downstream duopoly case, denoted Π_{UI}^{DS}, to evaluate the condition

$$\Pi^M > \Pi_{UI}^{DS}. \tag{7.7}$$

(i) Monopoly. When E is not active, the demand function from equation (3.3) reduces to $p_I = 1 - q_I$. The monopoly profit is given by $\Pi^M = p_I q_I = (1 - q_I)q_I$ (recall that U's marginal costs are normalized to zero). The monopoly profit is the same for price and quantity competition. The monopolist maximizes $\Pi^M(q_I) = (1-q_I)\, q_I$ with respect to q_I. The equilibrium quantity is $q^M = 1/2$ and the equilibrium price is $p^M = 1/2$. The joint profit of U and I without downstream entry and irrespective of integration or separation is thus given by

$$\Pi^M = \frac{1}{4}.$$

(ii) Separation and downstream duopoly. The joint profit Π_{UI}^{DS} is given by

$$\widetilde{p}\left(w^{DS}, w^{DS}\right) \widetilde{q}\left(w^{DS}, w^{DS}\right) + w^{DS} \widetilde{q}\left(w^{DS}, w^{DS}\right) + \left(\pi\left(w^{DS}, w^{DS}\right) - \pi\left(c, w^{DS}\right)\right).$$

We distinguish between price competition (ii.a) and quantity competition (ii.b).
Given the restriction $w^{DS} > 0$ applies, we distinguish between three different cases:

1. The fringe is relatively efficient: $c < c^e$, where the latter is a threshold that we define below, such that we need a restriction $w^{DS} \leq c^e$ to ensure that the fixed fees do not become negative in the case of price competition and that the unit input price does not become negative in the case of quantity competition ($w^{DS} \geq 0$).

2. Effectively no alternative supply exists as the unit cost of the alternative are so large that the outside option profit is zero: $c > c^m$, with $\pi(c, w) = 0$ and $\pi(c, 0) = 0$.

3. U is unrestricted in its choice of a unit input price, such that we derive w^{DS} from the first order condition.

(ii.a) Price competition. As described above, the unit input price can now take three values. For $c < c^e \equiv \gamma^2/4$ the fringe imposes a constraint on U's choice of w, such that $w^{DS} = c$. For $c > c^m \equiv (\gamma^2 + 2\gamma - 4)/(2\gamma^2 - 2)$ effectively no alternative sourcing exists for the downstream firms:

$$w^{DS} = \begin{cases} c & \text{if } c < c^e \equiv \frac{\gamma^2}{4}, \\ \frac{\gamma}{2} & \text{if } c > c^m \equiv \frac{\gamma^2+2\gamma-4}{2(\gamma^2-2)}, \\ \frac{\gamma\left(\gamma\left(\gamma^2+\gamma-2\right)+2\left(\gamma^2-2\right)c\right)}{2(\gamma^3+2\gamma^2-4)} & \text{if } c^e < c < c^m. \end{cases} \tag{7.8}$$

With w^{DS} as defined in equation (7.8), we obtain the following equilibrium prices and quantities:

$$\widetilde{p}\left(w^{DS}, w^{DS}\right) = \begin{cases} \frac{\gamma-c-1}{\gamma-2} & \text{if } c < c^e, \\ \frac{1}{2} & \text{if } c > c^m, \\ \frac{\gamma^4-2\gamma^2+\gamma^3(1-2c)+4\gamma(c-2)+8}{2(\gamma^4-4\gamma^2-4\gamma+8)} & \text{if } c^e < c < c^m; \end{cases}$$

$$\widetilde{q}\left(w^{DS}, w^{DS}\right) = \begin{cases} \frac{c-1}{(\gamma-2)(\gamma+1)} & \text{if } c < c^e, \\ \frac{1}{2\gamma+2} & \text{if } c > c^m, \\ \frac{\gamma^4-\gamma^3-6\gamma^2+2\left(\gamma^2-2\right)\gamma c+8}{2(\gamma-2)(\gamma+1)(\gamma^3+2\gamma^2-4)} & \text{if } c^e < c < c^m. \end{cases} \tag{7.9}$$

This yields the equilibrium profits:

$$\pi\left(w^{DS},w^{DS}\right)=\begin{cases}\frac{(1-\gamma)(1-c)^2}{(\gamma-2)^2(\gamma+1)} & \text{if } c<c^e,\\ \frac{1-\gamma}{4\gamma+4} & \text{if } c>c^m,\\ \frac{(1-\gamma)\left(\gamma^4-\gamma^3-6\gamma^2+2\left(\gamma^2-2\right)\gamma c+8\right)^2}{4(\gamma+1)(\gamma^4-4\gamma^2-4\gamma+8)^2} & \text{if } c^e<c<c^m;\end{cases}$$

$$\pi\left(c,w^{DS}\right)=\begin{cases}\frac{(1-\gamma)(1-c)^2}{(\gamma-2)^2(\gamma+1)} & \text{if } c<c^e,\\ 0 & \text{if } c>c^m,\\ \frac{(1-\gamma)(\gamma+2)^2\left(\gamma^2+2\gamma-2\left(\gamma^2-2\right)c-4\right)^2}{4(\gamma+1)(\gamma^4-4\gamma^2-4\gamma+8)^2} & \text{if } c^e<c<c^m.\end{cases} \tag{7.10}$$

Consequently, the joint profit Π_{UI}^{DS} is

$$\begin{cases}\frac{(c-1)(\gamma+(\gamma-3)c-1)}{(\gamma-2)^2(\gamma+1)} & \text{if } c<c^e,\\ \frac{1}{2\gamma+2} & \text{if } c>c^m,\\ \frac{2\left((\gamma-1)\gamma^4+4\left(\gamma^2-2\right)^2c^2-4\left(\gamma^4+2\gamma^3-6\gamma^2-4\gamma+8\right)c\right)}{4(\gamma-2)^2\left(\gamma^3+2\gamma^2-4\right)(\gamma+1)}-\frac{(\gamma-1)(\gamma+2)^2\left(\gamma^2+2\gamma-2\left(\gamma^2-2\right)c-4\right)^2}{4\left(\gamma^4-4\gamma^2-4\gamma+8\right)^2(\gamma+1)} & \textit{else}.\end{cases}$$

We can now evaluate condition (7.7) to find out for which values of γ and c integration is profitable. Straightforward calculations show that integration is profitable when

$$c<\bar{c}_{Bertrand}\left(\gamma\right),$$

with

$$\bar{c}_{Bertrand}\left(\gamma\right)\equiv\frac{\gamma^2+2\gamma-4}{2\left(\gamma^2-2\right)} \tag{7.11}$$

$$-\frac{1}{2}\sqrt{\frac{\gamma^9-\gamma^8-8\gamma^7+40\gamma^5-80\gamma^3-16\gamma^2+128\gamma-64}{\left(\gamma^2-2\right)^2\left(\gamma^3+\gamma^2-4\right)}}. \tag{7.12}$$

(ii.b) Quantity competition. Also for quantity competition, the unit cost price can now take three values. We know the third value already from equation (7.5) in the proof of Proposition 3. For $c<c^e\equiv(1/4)\left(2\gamma-\gamma^2\right)$ the fringe imposes a constraint on U's choice of w, such that $w^{DS}=0$. For $c>c^m\equiv\left(4+2\gamma-\gamma^2\right)/4\left(\gamma+1\right)$ no outside option exists for the downstream firms:

$$w^{DS}=\begin{cases}0 & \text{if } c<c^e\equiv\frac{1}{4}(2\gamma-\gamma^2),\\ \frac{\gamma}{2\gamma+2} & \text{if } c>c^m\equiv\frac{4+2\gamma-\gamma^2}{4(\gamma+1)},\\ \frac{\gamma((\gamma-2)\gamma+4c)}{2(\gamma^3-2\gamma^2+4)} & \text{if } c^e<c<c^m.\end{cases} \tag{7.13}$$

The equilibrium input price as defined in equation 7.13 yields the following equilibrium downstream price and quantity:

$$\widetilde{p}\left(w^{DS},w^{DS}\right)=\begin{cases}\frac{1}{\gamma+2} & \text{if } c<c^e,\\ \frac{1}{2} & \text{if } c>c^m,\\ \frac{\gamma^4+\gamma^3-6\gamma^2+4(\gamma+1)\gamma c+8}{2(\gamma^4-4\gamma^2+4\gamma+8)} & \text{if } c^e<c<c^m,\end{cases}$$

$$\widetilde{q}\left(w^{DS}, w^{DS}\right) = \begin{cases} \frac{1}{\gamma+2} & \text{if } c < c^e, \\ \frac{1}{2\gamma+2} & \text{if } c > c^m, \\ \frac{\gamma^3-2\gamma^2-4\gamma c+8}{2\gamma^4-8\gamma^2+8\gamma+16} & \text{if } c^e < c < c^m, \end{cases} \tag{7.14}$$

and the following equilibrium profits:

$$\pi\left(w^{DS}, w^{DS}\right) = \begin{cases} \frac{1}{(\gamma+2)^2} & \text{if } c < c^e, \\ \frac{1}{4(\gamma+1)^2} & \text{if } c > c^m, \\ \frac{\left(\gamma^3-2\gamma^2-4\gamma c+8\right)^2}{4(\gamma^4-4\gamma^2+4\gamma+8)^2} & \text{if } c^e < c < c^m, \end{cases}$$

$$\pi\left(c, w^{DS}\right) = \begin{cases} \frac{(\gamma+2c-2)^2}{(\gamma^2-4)^2} & \text{if } c < c^e, \\ 0 & \text{if } c > c^m, \\ \frac{(\gamma-2)^2\left(\gamma^2-2\gamma+4(\gamma+1)c-4\right)^2}{4(\gamma^4-4\gamma^2+4\gamma+8)^2} & \text{if } c^e < c < c^m. \end{cases} \tag{7.15}$$

The joint profit Π_{UI}^{DS} is thus given by

$$\begin{cases} \frac{(\gamma-2)^2-4c^2-4(\gamma-2)c}{(\gamma^2-4)^2} & \text{if } c < c^e, \\ \frac{1}{2\gamma+2} & \text{if } c > c^m, \\ \frac{1}{4}\left(\frac{2\left(\gamma^4-16(\gamma+1)c^2-8\left(\gamma^2-2\gamma-4\right)c\right)}{(\gamma+2)^2(\gamma^3-2\gamma^2+4)} + \frac{(\gamma-2)^2\left(\gamma^2-2\gamma+4(\gamma+1)c-4\right)^2}{(\gamma^4-4\gamma^2+4\gamma+8)^2}\right) & \text{if } c^e < c < c^m. \end{cases}$$

As under price competition, we evaluate condition (7.7) to infer about the merger profitability. Straightforward calculations yield that entry-deterring vertical integration is profitable when

$$c < \bar{c}_{Cournot}(\gamma),$$

with $\bar{c}_{Cournot}(\gamma)$

$$\equiv \frac{4+2\gamma-\gamma^2}{4(\gamma+1)} - \frac{1}{4}\sqrt{\frac{-\gamma^9+\gamma^8+8\gamma^7-16\gamma^6-24\gamma^5+64\gamma^4+16\gamma^3-112\gamma^2+64}{(\gamma+1)^2(\gamma^3-\gamma^2+4)}}. \tag{7.16}$$

□

Proof of Proposition 5. To compute welfare, we plug the equilibrium quantities of 1/2 and 0 in the monopoly case and the quantities in equation (7.9) for Bertrand and equation (7.14) for Cournot in the duopoly case into the welfare function $W(q_I, q_E) = u(q_I, q_E) - \theta \cdot I(\text{entry})$ from equation (3.4). We thus compare welfare for the case that no entry occurs (downstream monopoly) W^M and for the case that E enters the market W^{DS}:

$$W^M > W^{DS}(\theta), \theta \in \left\{\underline{\theta}, \overline{\theta}\right\}. \tag{7.17}$$

As entry costs are defined within a range of $\pi(c,0) < \theta < \pi\left(c, w^{DS}\right)$, we compute a lower bound with the highest possible entry costs $\left(\bar{\theta} = \pi\left(c, w^{DS}\right)\right)$ for welfare. The upper bound with the lowest possible entry costs would be given by $\underline{\theta} = \pi(c,0)$.
For vertical integration and the downstream monopoly, we get

$$W^M = \frac{3}{8}.$$

For **Bertrand**, we get $W^{DS}(\theta)$

$$\begin{cases} \frac{(1-c)(-2\gamma+c+3)}{(\gamma-2)^2(\gamma+1)} - \theta & \text{if}\, c < c^e, \\ \frac{3}{4\gamma+4} - \theta & \text{if}\, c > c^m, \\ \frac{\left(3\gamma^4-10\gamma^2+\gamma^3(1-2c)+4\gamma(c-4)+24\right)\left(\gamma^4-\gamma^3-6\gamma^2+2\left(\gamma^2-2\right)\gamma c+8\right)}{4(\gamma+1)\left(\gamma^4-4\gamma^2-4\gamma+8\right)^2} - \theta & \text{if } c^e < c < c^m. \end{cases}$$

We know $\bar{\theta}$ from equation (7.10) in the proof of Proposition 4:

$$\bar{\theta} = \begin{cases} \frac{(1-\gamma)(1-c)^2}{(\gamma-2)^2(\gamma+1)} & \text{if}\, c < c^e, \\ 0 & \text{if}\, c > c^m, \\ \frac{(1-\gamma)(\gamma+2)^2\left(\gamma^2+2\gamma-2\left(\gamma^2-2\right)c-4\right)^2}{4(\gamma+1)\left(\gamma^4-4\gamma^2-4\gamma+8\right)^2} & \text{if } c^e < c < c^m. \end{cases}$$

The lower bound of welfare under entry and separation is given by

$$W^{DS}\left(\theta = \bar{\theta}\right).$$

A comparison of the integration welfare with the lower bound of the separation welfare, as in equation (7.17), shows that separation yields the higher welfare for all relevant values of c and γ. This finding is illustrated in figure 4.3.

For **Cournot**, we get

$$W^{DS}(\theta) = \begin{cases} \frac{\gamma+3}{(\gamma+2)^2} - \theta & \text{if}\, c < c^e, \\ \frac{3}{4\gamma+4} - \theta & \text{if}\, c > c^m, \\ \frac{\left(\gamma^3-2\gamma^2-4\gamma c+8\right)\left(\gamma^4+\gamma^3-6\gamma^2+4(\gamma+1)\gamma c+8\right)}{2\left(\gamma^4-4\gamma^2+4\gamma+8\right)^2} - \theta & \text{if } c^e < c < c^m. \end{cases}$$

The lower bound of welfare under vertical separation and duopoly is given by

$$W^{DS}\left(\theta = \bar{\theta}\right),$$

with

$$\bar{\theta} = \begin{cases} \frac{(\gamma+2c-2)^2}{\left(\gamma^2-4\right)^2} & \text{if}\, c < c^e, \\ 0 & \text{if}\, c > c^m, \\ \frac{(\gamma-2)^2\left(\gamma^2-2\gamma+4(\gamma+1)c-4\right)^2}{4\left(\gamma^4-4\gamma^2+4\gamma+8\right)^2} & \text{if } c^e < c < c^m, \end{cases}$$

where we know $\bar{\theta}$ from equation (7.15).
Evaluating condition (7.17) reveals that the integration welfare is larger than the separation welfare when $c < \widetilde{c}(\gamma)$ and $\gamma > \widetilde{\gamma}$, with

$$\widetilde{\gamma} = \frac{2}{3} \text{ and } \widetilde{c}(\gamma) = \frac{2-\gamma}{2} - \frac{\sqrt{-3\gamma^4+8\gamma^3+16\gamma^2-64\gamma+48}}{4\sqrt{2}},$$

and $\widetilde{c}'(\gamma) > 0$ for $\gamma > \widetilde{\gamma}$.

For the parameter range where welfare is lower under vertical separation, the unit input price is non-positive. Formally: $\widetilde{c}(\gamma) > \hat{c}(\gamma)$ in the relevant range, where the latter is defined in the proof of Proposition 3. This means that these cases are excluded from the current proposition as vertical integration does not deter entry. Consequently, for the relevant parameter range, welfare is strictly higher under vertical separation and duopoly than under vertical integration and monopoly. □

Proof of Lemma 6. We distinguish two cases:

1. To ensure that the fixed fee is positive the unit input price is set to c in case $w > c$. This is the case when $c < c^e \equiv \frac{\gamma^3-\gamma^2}{\gamma^2+2\gamma-4}$.
2. The unit input price w as defined by the first order condition of U's maximization problem for all cases where $w \leq c$.

From equation (7.8) we know that the equilibrium unit price without exclusive dealing and price competition is

$$w^{DS} = \begin{cases} c & \text{if } c < c^e \equiv \frac{\gamma^2}{4}, \\ \frac{\gamma\left(\gamma\left(\gamma^2+\gamma-2\right)+2\left(\gamma^2-2\right)c\right)}{2\left(\gamma^3+2\gamma^2-4\right)} & \text{if } c^e < c. \end{cases}$$

With exclusive dealing, U maximizes

$$\Pi_U = w \cdot \widetilde{q}(w,c) + \pi(w,c) - \pi(c,c), \tag{7.18}$$

where

$$\widetilde{q}(w,c) = \frac{-\gamma^2 + \gamma(c-1) + \left(\gamma^2-2\right)w + 2}{\gamma^4 - 5\gamma^2 + 4}$$

and

$$\pi(w,c) = \left(\gamma^2 + \gamma - \gamma c + \gamma^2(-w) + 2w - 2\right)^2.$$

The alternative sourcing profit $\pi(c,c)$ of firm I equals

$$\pi(c,c) = -\frac{(\gamma-1)(c-1)^2}{(\gamma-2)^2(\gamma+1)}.$$

Plugging these values into equation (7.18) and maximizing with respect to w yields

$$w^{ED} = \begin{cases} c & \text{if } c < c^e \equiv \frac{\gamma^3-\gamma^2}{\gamma^2+2\gamma-4} \\ \frac{\gamma^2\left(\gamma^2+\gamma-\gamma c-2\right)}{4\left(\gamma^2-2\right)} & \text{if } c > c^e. \end{cases} \tag{7.19}$$

Equation (7.19) implies that w^{ED} is not below c. Recall that $c > 0$ by assumption. We conclude that $w^{ED} > 0$. We can now compute for which values of c the condition $w^{ED} < w^{DS}$ holds, which implies $\pi\left(c, w^{ED}\right) < \pi\left(c, w^{DS}\right)$. A comparison of the unit input prices shows that exclusive dealing can be used as an entry deterring device when

$$\frac{\gamma^3-\gamma^2}{\gamma^2+2\gamma-4} < c < 1, \tag{7.20}$$

where $\frac{\gamma^3-\gamma^2}{\gamma^2+2\gamma-4}$ is between 0 and 0.073 for $0<\gamma<1$. □

Proof of Lemma 7. To prove that exclusive dealing is as deterrent as vertical integration under quantity competition, we show that U sets a unit input price $w^{ED}=0$ when the input price is restricted to be non-negative.

Under exclusive dealing, U maximizes

$$\Pi_U = w \cdot \widetilde{q}\,(w,c) + \pi\,(w,c) - \pi\,(c,c)\,, \tag{7.21}$$

where I's quantity is

$$\widetilde{q}\,(w,c) = \frac{\gamma-\gamma c+2w-2}{\gamma^2-4},$$

and I's flow profit is

$$\pi\,(w,c) = \frac{(\gamma-\gamma c+2w-2)^2}{\left(\gamma^2-4\right)^2}$$

The incumbent I obtains an alternative sourcing profit equal to

$$\pi\,(c,c) = \frac{(c-1)^2}{(\gamma+2)^2}.$$

Plugging these values into equation (7.21) yields the equilibrium input price

$$w^{ED} = \frac{\gamma^2(\gamma(c-1)+2)}{4\,(\gamma^2-2)}.$$

For all values of $0<c<1$ and $0\le\gamma<1$, the equilibirum input price is negative, as the denominator is negative: $\gamma^2-2<0$ while the numerator is positive: $\gamma\,(c-1)>-2$.

To establish whether U chooses to set $w^{ED}=0$ when input prices are restricted to be non-negative, we compute the second derivative, which is negative:

$$\frac{\partial^2\Pi_U}{(\partial w)^2} = \frac{4\,(\gamma^2-2)}{\left(\gamma^2-4\right)^2} < 0. \tag{7.22}$$

This implies that U sets $w^{ED}=0$ when it deals exclusively with I and the downstream firms compete in quantities. It follows that $w^{ED}<w^{DS}$ for all $c>\hat{c}$, as defined in equation (7.6), and $w^{ED}=w^{DS}$ for all $c<\hat{c}$. □

Appendix B: Small entry costs

Our analysis of merger profitability and welfare in section 4.3 focuses on intermediate entry cost ($\pi\,(c,0)<\theta\le\pi\left(c,w^{DS}\right)$), such that entry takes place under vertical separation whereas vertical integration deters entry. To assess welfare and the profitability of vertical integration, we compare a monopoly situation with a duopoly situation under vertical separation. For small entry costs ($\theta<\pi\,(c,0)$) – where in our setting entry always takes place – the relevant comparison is that of vertical integration and vertical separation both under duopoly. For intermediate entry costs, the case of vertical integration and duopoly never materializes when vertical integration deters entry but is rationally anticipated by the entrant when deciding whether to enter the market. See table 2 for a comparison.

		Vertical link between U and I	
		Integration	**S**eparation
Downstream market structure	**M**onopoly (only I)	MI ← *our comparison*	MS
	Duopoly (I and E)	DI ← – – comparison small θ	– – → DS

Table 2: Combinations of entry and vertical ownership. The solid arrow depicts the comparison that we make in section 4.3. The dashed arrow shows the comparison in case of small entry costs.

For small entry costs, our model resembles Sandonís and Faulí-Oller (2006). They focus on the licensing effects of an innovation as internal or external patentee and, in addition, briefly relate to market foreclosure in a downstream duopoly without entry.[39] For vertical separation and duopoly, they also consider non-negative unit input prices under Cournot competition and unit prices weakly below the alternative cost of c under price competition.[40]

Welfare analysis. With small entry costs, the welfare effects of vertical integration depend purely on how vertical integration affects the downstream prices relative to vertical separation. There is a trade-off between

1. eliminated double marginalization with vertical integration and
2. the outside option profits $\pi(c, w^{DS})$ under vertical separation disciplining the wholesale price level of both downstream firms.

The welfare analysis in our baseline model (intermediate entry cost, see section 6.1) differs as it essentially compares a downstream monopoly and duopoly setting. Therefore, entry-deterring vertical integration decreases welfare for all upstream efficiency differentials (Proposition 5), for quantity as well as for price competition. The optimal merger policy is simple: When entry and potential competition is of concern in a market, a vertical merger is welfare decreasing and should be prohibited absent further efficiencies as it tends to deter entry.[41] Our analysis thus suggests the presumption of anti-competitive vertical mergers in the model at hand.

This differs partly in the case of small entry costs as studied by Sandonís and Faulí-Oller (2006). Here, vertical integration eliminates double marginalization without monopolizing the downstream market (as it happens in our case), which can increase welfare for both forms of competition. Under quantity competition, vertical integration increases welfare when the effect of intensified competition through the elimination of double marginalization prevails. As this reduces the profit of the integrated firms, integration is not profitable when it increases welfare.

In the case of Bertrand competition, the efficient supplier charges the highest possible unit input price equal to the exogenous c when upstream competition is strong enough under both,

[39] Sandonís and Faulí-Oller (2006) do not consider entry costs at all. However, when the entry cost are small enough, they are fixed sunk cost in both ownership cases (vertical integration and vertical separation) and therefore do not affect comparisons of profits and welfare across the cases (at least in absolute terms).

[40] Please see the discussion at the end of section 4.2 for further details.

[41] This holds strictly for price competition and when unit input prices above marginal costs are expected under vertical separation and downstream duopoly. For the case of unit input prices at costs, the results of the case with small entry costs apply if entry is feasible. When entry is not feasible, the merger is welfare-neutral.

vertical separation and integration.[42] In that case, a profitable merger increases welfare through the elimination of double marginalization when the products are weakly differentiated (γ large) and upstream competition is strong (c small). For a more detailed analysis and explanation of the effects please refer to Sandonís and Faulí-Oller (2006).

We conclude that a competition authority should use the insights of both Sandonís and Faulí-Oller and our article to appropriately distinguish between actual and potential competition (entry) when assessing the likely effects of the merger. Our analysis of intermediate entry costs thus complements the analysis of Sandonís and Faulí-Oller (2006) in the highly relevant dimension of potential competition.

[42] Thus, for c small the prices under separation are given by $\widetilde{p}(c,c)$ and under integration by $\widetilde{p}(c,0)$ respectively $\widetilde{p}(0,c)$. From that we can directly see that integration decreases consumer prices.

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